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FIG. 1. ENTRANCE TO TUNNEL NO. 20.

## ELECTRIC-AIR DRILLS IN JAPANESE TUNNELS

BY CHAS. A. HIRSCHBERG.

A project involving the building of a high pressure power line, 8½ miles long, is being put through between Kurobe and Shimotaki, Japan, by the Kinugawa Hydro Electric Power Company of Tokyo to develop 60,000 Horse Power from the rapids of the Kinu River. The electric current generated is to be transmitted 80 miles to the city of Tokyo.

A 200 foot concrete dam is being built across the Kinu River at Kurobe, from whence the water will be conducted (through tunnels being driven) to Sakasegawa, four miles distant, where a head regulating basin and impounding reservoir are being built of sufficient size to effectually regulate the flow. The spillway of this reservoir will be 40 feet high above the bottom of the head tank located at Shimotaki 4½ miles further distant.

The building of this line involves the driving of 25 tunnels of various lengths 7 ft. x 8 ft. in cross section, in addition to considerable open cut work to carry a flow of 700 cubic feet per second. The available head of water at Shimotaki approximates 1020 feet.

Work was started in April, 1910, under the

direction of Messrs. Toshimitsu and Kobayashi, Managers of the Kinugawa Hydro Electric Power Company and Professor Hiroi the Consulting Engineer in charge, and from present indications the project will be completed in the early part of 1913.

Very remarkable speed is being attained in the driving of the tunnels in spite of the very hard rock encountered—a blue blende formation—blue granite and quartz porphyry. An idea of the hardness of this rock may be gained from the fact that from 200 to 250 drill steels are required to put in a round of 13 holes averaging 4 to 5 feet deep.

A variety of air driven drills were at first used, air for which was furnished by eleven belted, Class "NE-1" type, Ingersoll-Rand compressors. Owing to the difficulties encountered in the transportation of heavy equipment and the fact that electric current was available the engineers purchased 12 4E Temple Ingersoll Electric Air Drills for part of the work. When the question of additional equipment came up, the engineers conducted a 10 day test to determine just what could be accomplished with various equipment which resulted in the addition of 20 more of this type of drill.

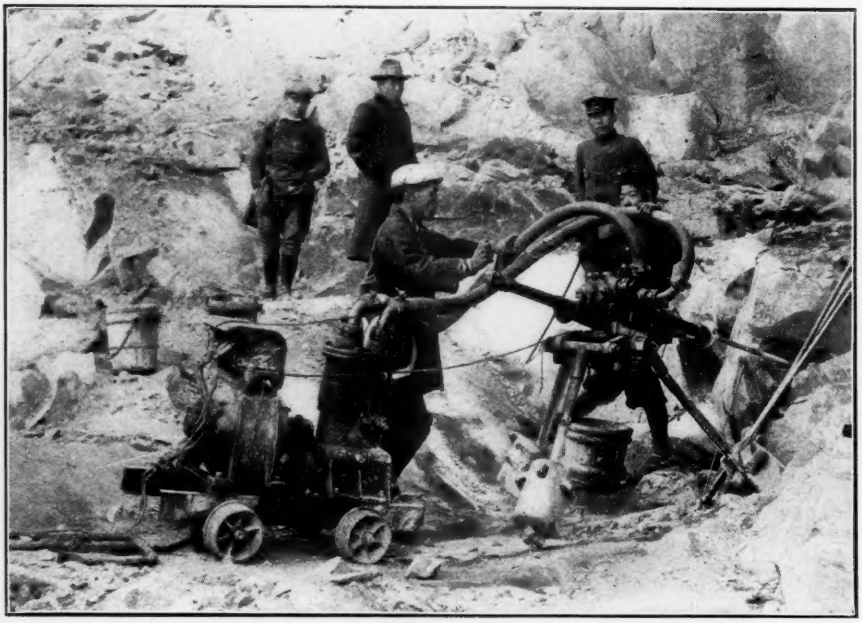

FIG. 2. DRILLING FOR OPEN CUT.

The scene of the test was in tunnel No. 20 and showed an average advance of 12 feet per day of three eight hour shifts, or a total of 120 feet for the ten days. Two 4E Temple Ingersoll drills were used, the pulsators being run in on two 18 inch tracks. Standard mining columns were used for mounting the drills.

The round of holes was drilled as numbered in the diagrams. In blasting, holes 6, 4 and 8, comprising the cut, were spitted first pulling a wedge shaped mass; this was followed by the back holes 1, 2 and 3, then the side holes 5, 9 and 10 and finally the lifters 13, 11 and 12.

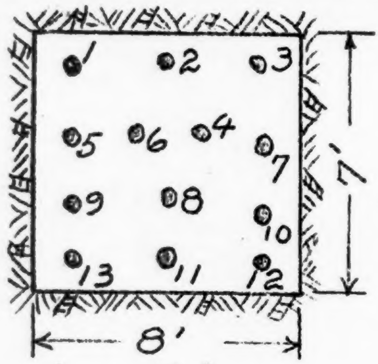


FIG. 3.

One hundred pounds of 70 per cent. nitroglycerine dynamite averaged the consumption per 24 hours. The average time for drilling a $4\frac{1}{2}$ foot hole was 30 minutes including time of changing steels, or a total average drilling time of 6 hours to the round, leaving 2 hours per shift for erecting columns and drills, blasting and mucking. The rock excavated average 224 cubic feet per 8 hour shift, a total of 672 cubic feet per day.

At Tunnel No. 21 similar results have been attained.

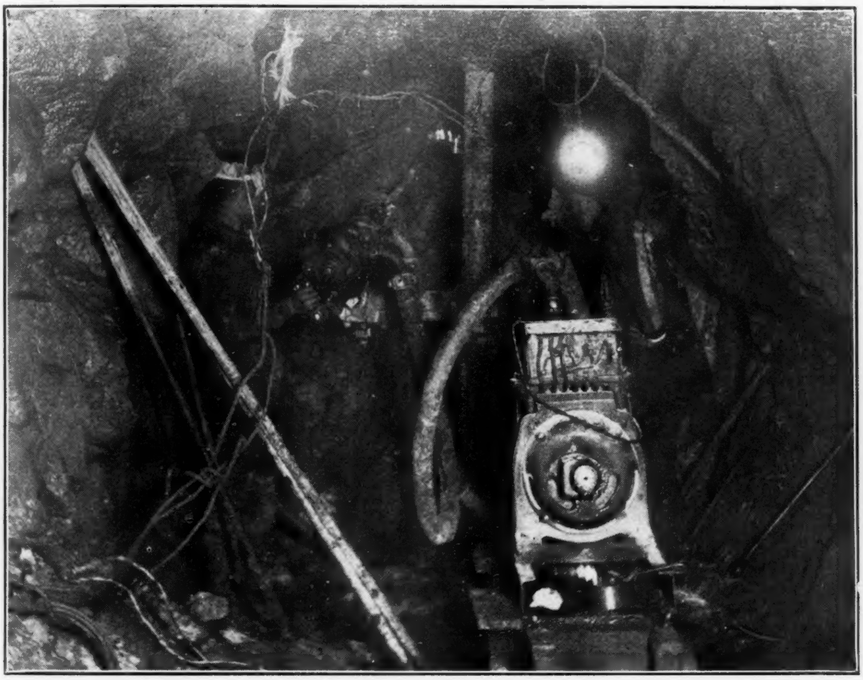

FIG. 4. DRILL DRIVING THE BREAST.

In Tunnel No. 15 where the rock is a moderately hard quartz porphyry the advance was somewhat greater, averaging 15 feet every three shifts.

The managers claim that the cost of driving these tunnels with the electric-air drill is considerably lower than that with air drills, while the saving effected through the elimination of compressor plant, pipe lines, etc., has proven very marked on this project.

In conclusion the writer wishes to express his thanks to Mr. T. Yokoyama, Civil Engineer with the Kinugawa Hydro Electric Power Co., for the data furnished.

## DIESEL AND SEMI-DIESEL DISTINCTIONS

Dr. Rudolph Diesel, in his recent trip to this country, used the following expression: "The Diesel engine is the only engine which converts the heat of the natural fuel into work in the cylinder itself without any previous transforming process, and which utilizes it as completely as the present advancement of science permits."

In a manuscript for a new book on gas engines, yet unpublished, the following is given as a brief description of the Diesel cycle. "Pure air only is drawn into the cylinder, and this is compressed to a point at which the temperature of compression is equal to or in excess of the combustion temperature of the fuel. The compression is from 350 to 550 lbs. per square inch. Just as the piston starts on the next outward stroke the fuel is forced in under a pressure slightly higher than that in the cylinder. The high temperature of the compressed air causes the entering fuel to take fire and burn as it enters the cylinder, just as gas burns when issuing from an ordinary gas burner. This does not increase the pressure in the cyl-

inder and no explosion takes place. The pressure, however, does not fall so rapidly during the admission of the fuel as it rose during the compression, and the expansion curve is therefore slightly higher in pressure than the compression curve. The exhaust takes place at a pressure near that of the atmosphere, and very little power is lost through the exhaust gases escaping at a comparatively high pressure as they do in the four cycle motor."

The term "semi-Diesel" has, however, come to be applied to engines using heavy fuel oils and operating in a general way on the Diesel principle. Most of these "Semi-Diesel" types are different from the Diesel engine in the manner in which the air is compressed and drawn into the cylinder and in the mamer of injection of the fuel. It will be noted that there is a large amount of misconception about what the Diesel type really is. A textbook on gas engines that is considered very reliable refers to the Diesel purely as a four-cycle engine, whereas it is built also in two-cycle units and in very large two-cycle sizes. "Semi-Diesel," therefore, is not a well defined term but is used to designate almost any low grade, liquid fuel engine which does not mix the air and fuel outside of the cylinder.—*The Gas Engine.*

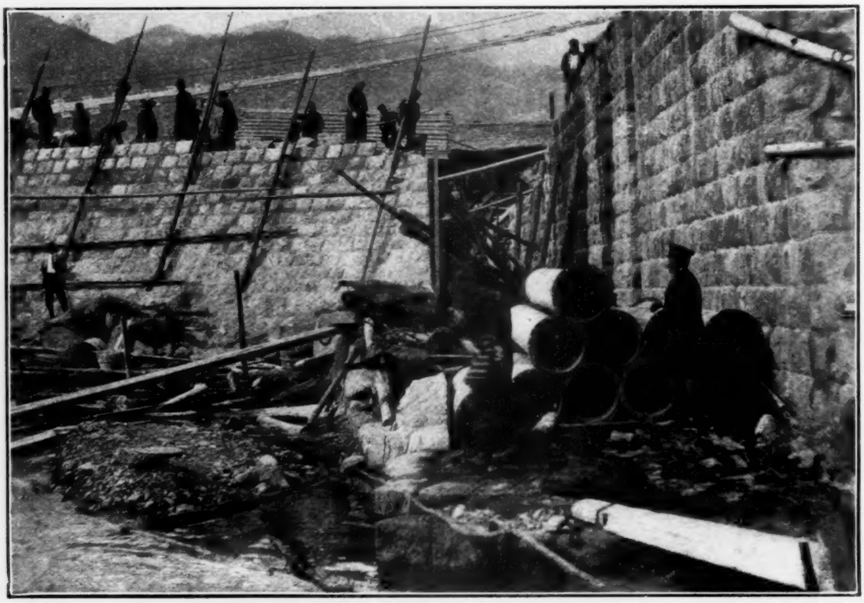

FIG. 5. KUROBE DAM UNDER CONSTRUCTION.

## AIR CUSHIONS FOR AUTOMOBILES

The air-cushion automobile invented by Josef Hofmann, the pianist, and constructed at the Saurer Machine Works in the consular district of St. Gall, Switzerland, promises to bring about a revolution in automobile construction. In place of the usual steel springs it has four brass cylinders for compressed air resting on the axles under the four corners of the automobile body, and these, by means of pistons and soft leather diaphragms, greatly reduce the swaying and jolting.

It is claimed for the new invention that it is adaptable to all kinds of roads, regardless of speed or weight of machine; that the air cushions work instantaneously with softness and ease of movement; that there is an entire absence of vibration, as no metal springs intervene between the axle and the car body; that there is almost perfect balance in rounding curves; and that there is as nearly perfect working safety as can be secured. The machine has been undergoing severe tests for several months, having already run more than 4,300 miles over unfavorable roads, and is said to have given great satisfaction. Within the past few days it has made a speed of 40 miles per hour over an unusually rough road with great ease of movement.—*Consular Reports.*

## THE JAPANESE LOYALTY AND THE MIKADO

BY W. L. SAUNDERS.

The death of the Emperor of Japan has excited a great deal of interest. Those who have visited the country and have studied conditions on the ground cannot but realize that Japan and the Japanese people are very much misunderstood. This is partly the fault of the Japanese themselves, who are not frank in giving information and who confuse questions relating to their government and people by statements that are at variance with each other.

During a recent visit to Japan I had an opportunity to get at the truth of many things from a distinguished Viscount, a professor at Tokyo University. It was from him that I learned that reliable Japanese history does not extend over a period of more than 600 or 800 years, notwithstanding the fact that even in the schools a history beyond that period is taught and believed by the common people.

The Japanese are exceedingly proud and jealous concerning all things relating to their country and people. No matter what he may think one can never get a Japanese to talk against his country or to criticise it in any way. There are, of course, intelligent and educated people in Japan who will frankly admit certain shortcomings, and who in answer to your questions will tell you the truth, but as a whole the Japanese people zealously guard the secrets of their country. This is to a certain extent commendable, because it is an exhibition of the intense loyalty of the people. They are loyal to their Sovereign, more loyal in fact than any other people on the face of the globe to-day. They are loyal to their ancestors, to their friends and to their country. Surely this spirit of loyalty is one of the highest of the virtues.

The Emperor is the embodiment of all that is great and good in the country. The whole history of modern Japan is written in the life of the Emperor who has recently passed away His reign of about forty-five years covers most of the period of modern Japan and it covers all the period of the actual Imperial reign, which was destroyed several hundred years ago when the Shoguns or generals came into power. In other countries revolutions usually affected the dynasty. The ruler was a party to or a victim of these upheavals, and dynasties were changed, kings were beheaded and governments upset. Not so with Japan. No revolutionist dared attack the Emperor. He was at all times the supreme power, and when, through the rise of powerful families, the control of the country passed to the Shoguns the Emperor, though retired and held in a glass case, was nevertheless respected and to him each Shogun paid tribute.

About forty-five years ago this condition of feudalism was destroyed by the abdication of the Shogunite and the restoration of the Emperor to power. This was the direct result of the opening of the door of civilization which had been going on for some fifteen years prior to the restoration.

It is unprecedented in the history of the world that a country should rise out of the depths of obscurity to become a progressive nation and a first-class power all in half a century, yet this is the history of Japan.

The present Emperor is a direct descendant of the first Emperor, though history is not clear as to who the first Emperor was. When the Chinese came over to Japan and introduced their Oriental civilization there, the Japanese found that the Chinese history dated back some two thousand years. This affected their pride to such an extent that they built up their own history as far back, at least, as that of the Chinese, and while much of this history must be taken as a romance yet no one doubts that the Imperial dynasty has remained unchanged.

It is a common mistake to say that the Japanese people look upon their Emperor as a god. There is little or no religion among the intelligent Japanese people. The old Shinto religion is confined mainly to the ignorant, and so is Buddhism. The educated Japanese may bow down to both the Shinto and the Buddha god, but he does not believe in either. He knows nothing about it, he sees no harm in it, it costs nothing, and so he accepts it; but he has no real, conscientious religious sentiment.

The true religion of Japan is loyalty, and this is symbolized in loyalty to the Sovereign. The war with Russia was an example of the practical working of this spirit of loyalty. Concentrate all the people on one idea and let that be devotion to the Emperor, which means, of course, patriotism, and it is difficult to withstand the onslaught. Japanese loyalty

creates not only enthusiasm but concentration of effort, determination and bravery itself. So long as this spirit exists, and so long as the financial resources of Japan are maintained, it will be difficult for any nation to conquer these people.

From a little magazine published in Japan called "The Musashino" I have extracted the following sentiments contained in an article written by Tae-Kichi Yahe, entitled "Our Sovereign:"

"Of Divine descent and mountaing a holy Throne that has never been marred by a tread of unhallowed foot, our Sovereign is the focus of our loftiest reverence and profoundest awe. Reigning, by virtue of the noble Heritage, over the Empire from the misty past in unbroken succession, he is the center of our most zealous devotion and highest regard. His exalted Person is absolutely inviolable, his peerless Grace completely immune, and his elevated State wholly inalienable. We are bound to him by a bond of traditions that we cherish most and are intent to preserve.

"An exaltation felt at the apprenhension of one's heritage imparts a moral force that weighs down one's temperament for the building up of his character. A proper sense of personal dignity, worthiness and responsibility, promoted from the remembrance of one's ancestry, gives rise to a lofty sentiment that uplifts one's spiritual constitution and fits him for the straight, upright walk of life.

"The remembrance of the past, the memory of the predecessors and the respect for the dead that peculiarly characterize the mind of the serious-minded people are a source of their unconquerable self-respect. They esteem their lineage and cherish the records of their progenitors, drawing thus ever fresh draught for their pride to thrive. Every cult exults at its sainted predecessors, and every family takes pride of its deified ancestors.

"To our Sovereign we owe a debt of gratitude that is 'deeper than the depth of an ocean and higher than the peak of a mountain.' He justly deserves our sincerest regard, our most genuine loyalty and our truest devotion. Our allegiance to him is eternal and absolute. We are glad to sacrifice our bodies, souls and all in defence of his Person, his dignity and his State. We are ready to die for preservation of his Heritage. The holy dominion over which he rules, and shall rule for ages to come, has been inherited; and not an inch of it shall be alienated while our eyes are open and the warm blood flows in our veins. One who dares to touch our Imperial is 'a foe with whom we shall not share abode under the same heavens.' An indignity or contempt that our Sovereign may have suffered would never have remained without a speedy reparation by his loyal subjects.

"It is upon these senses of obligation and feeling of gratitude that the mighty structure of the Japanese patriotism and loyalty is built, that the lofty virtue of fidelity and mutual love and the exalted sense of honor of the people rest."

## RAINFALL, EVAPORATION AND DRAINAGE

Mr. George A. Lindsay, in the Transactions of the Academy of Science, St. Louis, gives in novel and striking form some interesting statistics of annual rainfall. The rainfall of the State of Missouri in a single year was 43.9 cubic miles. In the same year 1,296.4 cubic miles of water is computed to have fallen over the whole area of the United States. These figures are tolerably comprehensible, but when we are told that the latter figures represent 6,000,000,000,000 tons of water then we are at sea again. As an illustration of the fact that most of the water that falls as rain never reaches the sea through the medium of drainage, but is evaporated from the land, Mr. Lindsay shows that the discharge of the Mississippi River at St. Louis is but little greater than the volume of rainfall over the State of Missouri alone, despite the enormous area drained by the river above that point.

## TO AVOID TIRE PUNCTURES

Basing his theory on the principle that the carriage must be suspended upon air, Count Lieut. Soliani of Italy asserts that he has discovered a method by which pneumatic tires may be protected against puncture. His method divides the present pneumatic tire into three small ones placed inside the wheel so as to be protected by the rim, which is of strong, unpuncturable material. The three pneumatics act exactly as do those now in use, suffer neither from heat nor puncturing, and wear indefinitely. The Italian military authorities have examined the new method and declare it perfect, and just as speedy and comfortable as the old.

## A NOVEL WAY OF TEACHING ROCK DRILLING

BY E. L. YOUNG.*

The mining department of the University of Missouri has developed methods and equipment for demonstrating in the class room and in the laboratory a number of important points in the practice of rock drilling and blasting, particularly as applied to drifting and tunneling.

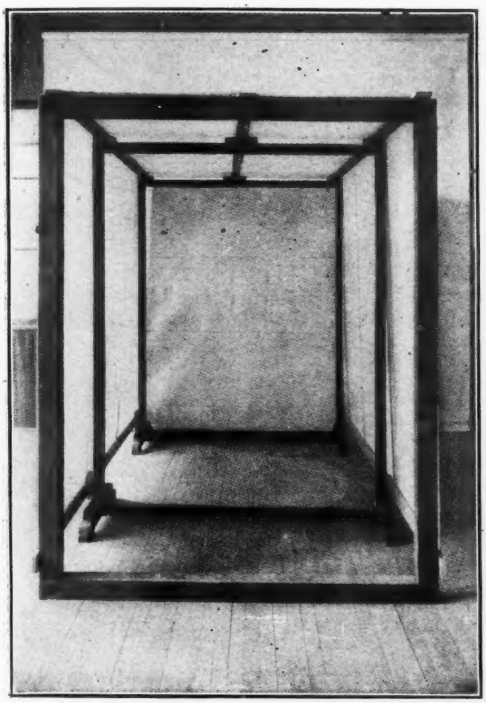

FIG. 1. THE APPARATUS.

Almost everyone who has attempted to teach rock drilling and blasting has been handicapped by the difficulty of instructing a large class of students in drifts and tunnels where only a few students can hear and see the instructor; by the difficulty underground of making students realize just where the holes are bottomed; by the difficulty of getting the student to realize exactly where the charge of powder goes; and by the impossibility of actually showing underground anything more than the drilled face of the drift before the charge is ignited, and the broken rock or the missed hole after the blast. Instructors have wished that they could show the bottom of each hole. It has seemed impossible to illustrate graphically the actual position of the several charges of dynamite and to demonstrate the distribution of the powder through the rock to be broken in tunnelling and drifting.

The equipment described in this article was designed primarily with the idea of inducing the student to think (in this exercise at least) of the bottom of the drill hole, of the actual volume of the rock to be broken by the powder, and of the new face of the drift rather than—as the student generally thinks—of the face of rock exposed, of certain customary set-ups of the drill, and of holes drilled according to custom. The idea has been to make the student think for himself and to give him an opportunity to see what can be done from certain set-ups of the rock drill.

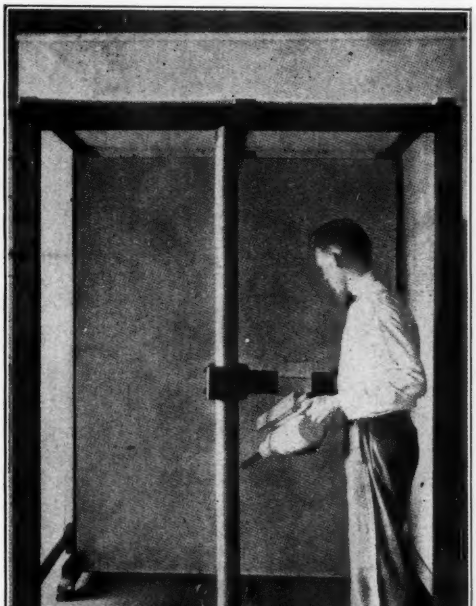

FIG. 2. DRILL SET-UP.

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HOLES REPRESENTED BY TIN TUBES.

The equipment consists essentially of the following: (1) Light-weight, full-size columns, bars, arms, and rock drills made of wood. Light-weight apparatus is used in order to save time and to make it possible for one man to demonstrate rapidly the various points under discussion. The rock drill is used only to show the position of the drill steel relative to the arm and the columns and the length of the feed. (2) Telescopic tin tubes are used to represent the holes drilled. The tubes are made in 2-ft. lengths of various diameters, as 1¼, 1⅜, 1½, 1⅝ in., etc., to represent the portion of the holes drilled with steel of a given gage. (3) Colored oilcloth is wrapped about the tin tubes, to indicate the position of the dynamite in the hole. Rubber bands are used to hold the oilcloth in place on the tin tubes. (4) A portable, light weight, 4-piece timber set, 5x7-ft. in the clear, is used to support the column or the bar. This is not intended to represent mine timber. (5) Portable screens are placed parallel to the 4-piece set. The purpose of the screens is to support the tin tubes when placed in position to represent the holes drilled. A sheet of paper is stretched over the screen near the 4-piece set and indicates the position of the face of the drift. The other screen is placed in position to indicate the face to which the drift

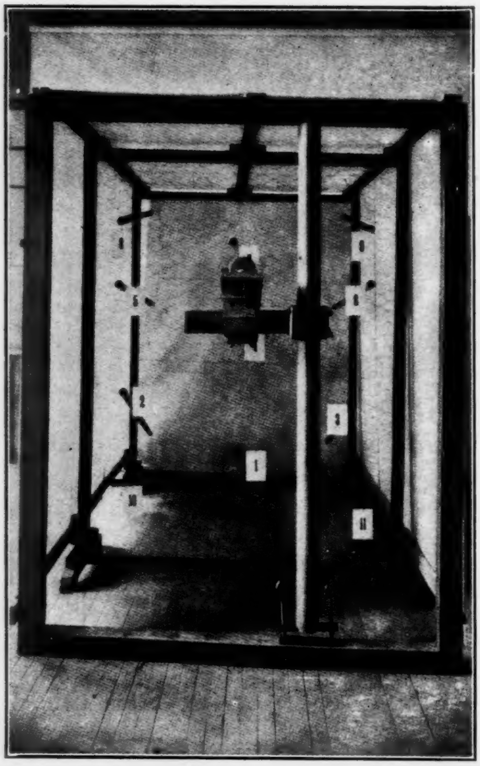

FIG. 3. TUBES IN PLACE.

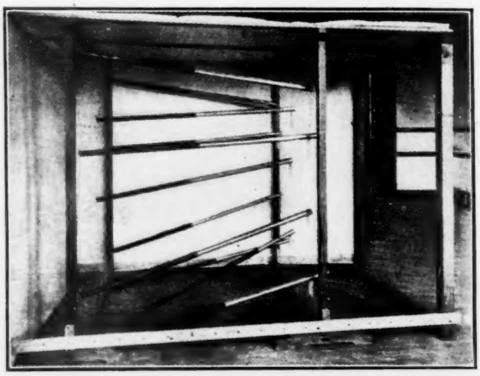

FIG. 4. SIDE VIEW OF FIG. 3.

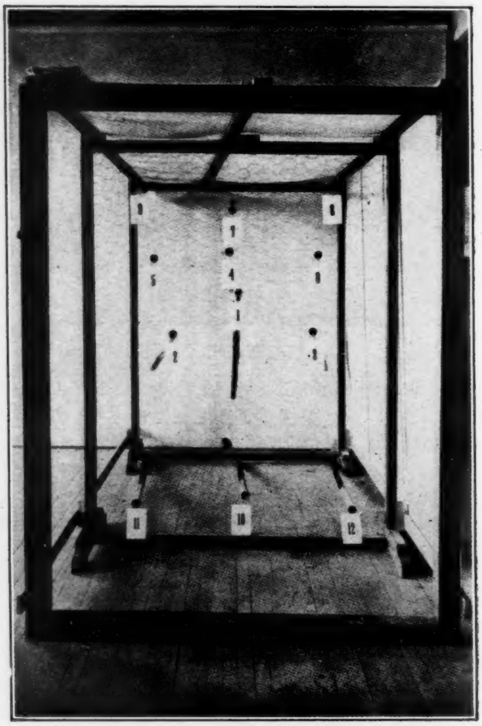

FIG. 5. TUBES TO SHOW ROUND OF HOLES AT LEONARD MINE, BUTTE.

will be advanced after the round of holes has been fired. The hook on the bottom of each tin tube representing a drill hole is hooked on the screen representing the face to be won, and the other end of the tube is supported by the rear screen. (6) Five 1x3-in. wooden strips are used as braces for the screens and the 4-piece set, and to support the canvas covering. (7) A canvas covering represents the walls and back of the drift. There are suitable eyelets for attaching the canvas to the wooden strips. This canvas covering is gen-

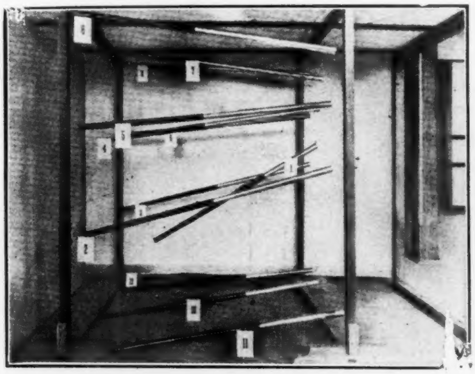

FIG. 6. SIDE VIEW OF FIG. 5.

erally not required as most of the students conceive the position of the walls and back without this actual inclosure. (8) Cardboard letters and numbers are used for labeling drill holes. These indicate the order of drilling, the set-up from which the hole is drilled, and the order of firing. (9) Wires are used to support the tin tubes which may be required to indicate the position of short cut-holes.

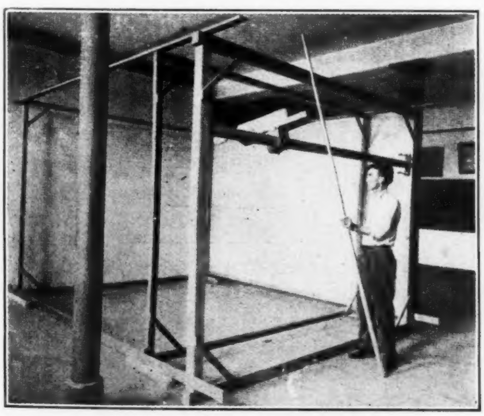

FIG. 7. TO SHOW TUNNEL, 8 BY 10 FT.

USE OF EQUIPMENT.

The use of this equipment may be illustrated as follows: A student is asked to demonstrate a set-up of a rock drill in a 5x7-ft. tunnel, and to show how the holes are placed. The equipment is placed at the beginning of the demonstration as shown in Fig. 1. Having explained where he expects to bottom each hole of the round necessary to break ground, the student shows (see Fig. 2) the first set-up and indicates where the second set-up will be, if more than one set-up is necessary.

The front screen is then covered with paper in order that the student may not have an opportunity to see more than he would if actual-

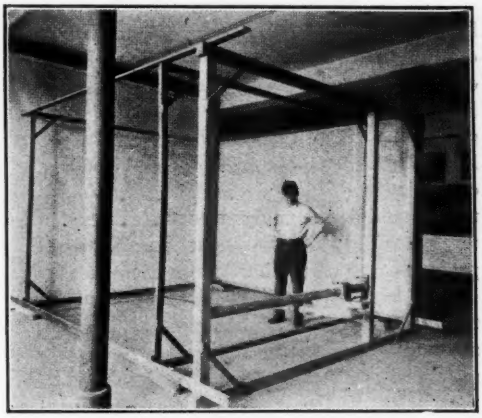

FIG. 8. STUDENT DETERMINING HEIGHT FOR BAR.

ly drilling into a face of rock. He then points each hole from the set-up, placing and hanging on the wire screens the several tin tubes necessary to show each hole drilled. He must show actually the size of hole he would drill, the necessary changes of gage of the drill bits, the angle of the hole, and the amount of powder charged. As designated by the student, one tin tube is put in place for each hole of the round. The student is not permitted to change any hole after it is bottomed. If more than one set-up is necessary, the work is carried on for the remaining set-ups in the same manner as for the first until each hole of the round is shown.

After the round has been placed, the paper is taken down then the student can examine and criticize his work (see Fig. 3). The instructor points out, among other things, the following: (a) The total footage of holes the student has used for the round. (b) The

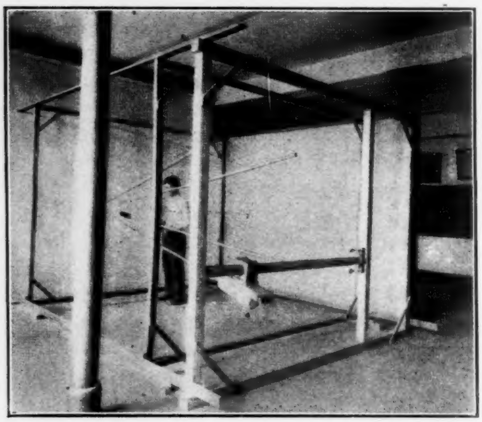

FIG. 9. STUDYING POSITION OF CUT HOLES.

holes that are unnecessarily long. (c) The danger of shooting the collar and primer off certain holes, providing the primer is put in last. (d) Any improvement possible in the angle of the holes, that is, where uppers might have been drilled to advantage instead of down holes or *vice versa.* (e) The position that would have made a more effective set-up. (f) Any improvement possible in the proportioning of the burden on each hole.

The student is reminded in each demonstration of the desirability of breaking the rock to a suitable size for shoveling; of the importance of having the "muck" thrown back from the face; of the importance of having the holes square the drift for the next round; and of the importance of placing the dynamite so that there may be no undue shattering of the walls and of the back.

It is not intended that this should in any way reduce the necessity for or the importance of demonstration and work with rock drills in a mine, but it has been found that many points may be made clearer by the use of this supplementary equipment. Moreover, the fact that there are "slips" and joints in rock has not been forgotten and that a set-up will depend largely on the way the last round broke. If the equipment and method described does nothing more than train the student to think of the burden he is putting on each hole, it will have accomplished much. These demonstrations have been of benefit to many who have had large experience in tunneling and drifting in hard rock.

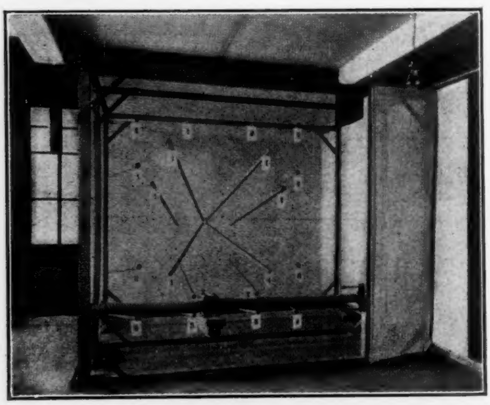

FIG. 10. ROUND OF HOLES TO SHOW LEYNER CUT.

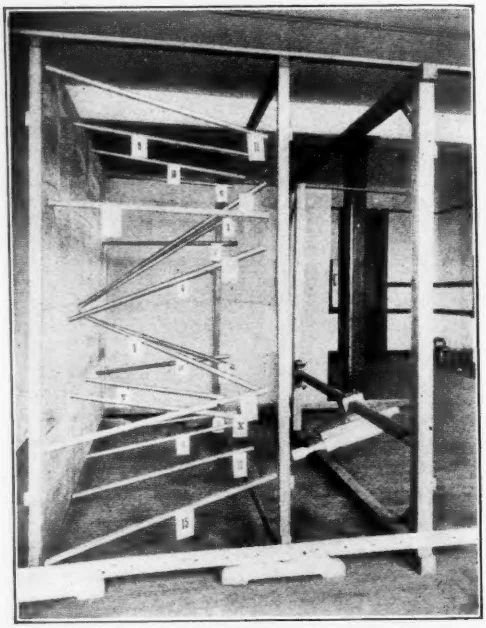

FIG. 11. SIDE VIEW OF FIG. 10.

Larger screens and other equipment are now being prepared in order to demonstrate graphically the pointing and loading of holes, and order of firing in tunnels of large cross section, such as the Roosevelt and the Laramie.

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No other gas is known which has the wide explosive limits of acetylene. Any mixture of air and acetylene containing between 3 per cent. and 8 per cent. of acetylene is explosive. Explosive mixtures are thus readily formed in pipes and also in the external neighborhood of leaky joints.

## EXPLOSIONS OF CARBONACEOUS DUST

The investigations which have been and are being carried out in nearly all mining countries into the explosibility of coal dust have convinced most people that this particular class of carbonaceous matter is even more dangerous than accumulations of fire-damp. But it is not only in the mine that disaster from this cause lies latent. It cannot be too clearly understood that wherever carbonaceous dust is produced, no matter from what source it arises, there is more than the possibility that sooner or later all the conditions requisite for the development of an explosion may simultaneously arise. The disastrous accidents which occurred at Messrs. Primrose's provender mill at Glasgow on the 10th of November last year, and at Messrs. Bibby's oil-cake mill at Liverpool a fortnight later fully illustrate our remarks.

Where the Glasgow explosion occurred, China beans, after washing and drying were crushed and broken between chilled cast iron plates and then ground between stones. The inspector has come to the conclusion that it was on the floor devoted to the latter millstones that the explosion originated. That it was a dust explosion there seems to be no room to doubt. A sample of dust collected from one of the beams in the mill was examined as to its explosive qualities. It was found to be ignitable at a temperature of 1050 deg. Cent., which is lower than the ignition point of many coal dusts. Further, the flame travelled appreciably faster through the bean dust than through most samples of coal dust tested in a similar manner. Mr. Smith is of the opinion that the disaster arose from the fall of some dust from an overhead beam into the naked flame of a gas jet used for lighting purposes, and that the propagation of the explosion is to be attributed to the disturbance of fresh dust by the initial explosion.

In the disaster at Liverpool there is every reason to suppose that the explosion started in a cellar containing a number of disintegrators employed for grinding oil-cake, locust beans, and other material. It is practically certain that the driving belt of a disintegrator broke and threw up a cloud of dust from the accumulation on the beams and machinery. How this cloud was ignited is less clear. There were no lighted gas jets in the neighborhood of the cellar at the time of the disaster, and on the whole the cause of ignition must be left an open question. Three plausible theories, however, have been advanced. It is possible that when the belt broke a workman may, in the darkened state of the room, have struck a match. Subsequent experiment showed that a cloud of the dust could be fired by an ordinary match when ignited in the cloud. In the second place, it is pointed out that the disintegrators were each provided with an electro-magnetic device for removing particles of iron from the feed. The wires of the magnets of one machine were found after the explosion to be broken and fused at the loose ends, and it is thus possible that the ignition of the dust was caused by a spark from these wires. Here, again, experimental confirmation can be produced, but the sequence of the breaking first of the belt and then of the magnet wires is not readily explainable. The third theory is based on the fact that a fuse wire near the broken belt, and forming part of the electric lighting circuit was subsequently found to have blown. In addition, a 16-candle power carbon incandescent lamp on the same circuit as the blown fuse was found to be broken after the explosion. This lamp is known to have been in use shortly before the disaster occurred. It is therefore, regarded as possible that the lamp broke coincidently with the belt, that "arcing over" took place, and that the fuse was in consequence blown.

The primary point to remember is this, that wherever carbonaceous dust of practically any kind is produced in any quantity conditions of safety should be enforced as rigorously as they are in a modern coal mine. This at once stamps the use of a naked flame for any purpose in such situations almost as criminal. If artificial light be required, incandescent electric lamps alone should be used. Particles of iron or steel in the material being ground should be removed by efficient electro-magnetic separators. Finally, every precaution should be taken against the escape of dust into the atmosphere, and if this, as is almost certain, cannot be completely avoided, thorough cleansing of all machines, elevators, conveyors, and wherever dust is liable to accumulate, should be carried out daily and preferably by suction methods.—From *The Engineer,* London.—(Condensed).

## COMPRESSED AIR TUNNEL DRIVING IN WET EARTH

Compressed air for tunneling through wet earth, without the use of a shield, was resorted to in completing the Eastview tunnel, a portion of the 127-mile aqueduct and delivery system which will supply water from the Catskill Mountains to New York City. The work is unique in that it is the only section of the Catskill project where compressed air has been used in a tunnel, although the upper portions of certain shafts on other parts of the line have been carried through water-bearing material overlying ledge-rock by means of pneumatic caissons.

In the Eastview tunnel, slightly more than a mile in length, water-bearing earth was encountered for a stretch of about 800 ft. near the center, after headings had been driven through solid ledge from two portals and an intermediate shaft. This condition was known in advance as the result of the exploratory borings, and provision was made in the contract for the use of compressed air should the ground developed require it. When repeated efforts to advance the tunnel through the soft material without air proved unsuccessful it was decided to change the scheme of construction from open air to compressed air work. Bulkheads and locks were installed, a compressor plant set up and pressure applied for the first time on Jan. 26, 1911, the initial pressure being 10 lb., gage. Since that time the work has been carried on continuously under air, the pressure varying from about 10 lb. to 26 lb.

The excavation in compressed air was carried on from one heading only (north from the shaft, called the south lock) in three stages according to the wall-plate drift scheme. The first operation consisted in driving two small side drifts in advance of the heading proper, one on either side of the section. These two preliminary drifts were made just large enough for a man to work in, and in them the wall-plates, in 20-ft. lengths, were set to line and grade. When the wall-plates had been placed the second step in the excavation was begun, namely, the removal of earth from the heading proper. After an advance of a foot or so had been made a set of timbers was immediately placed to support the roof. The third operation consisted in removing the material from the bench. Side trenches, about 3 ft. wide, were excavated a few feet in advance of the main bench and 12 x 12-in. plumb-posts were set to support the wall-plates. After these had been set the remainder of the bench was removed and the operation repeated until there was room to place another set of timbers. Later grout, in the proportions of 1 part cement to 2 parts sand, was forced back of the timber for 400 ft. in the worst ground to fill any voids.

On account of the character of the wet earth there was a tendency for the material to flow upward through the bottom of the tunnel in the softest ground, and solid 12 x 12-in. invert timbering, covering a stretch of 300 ft., was placed sloping downward toward the center from each side so as to form a flat V and afford some degree of arch action. The joints in the segmental arch timbering were made secure by wooden cleats, 2 in. thick, spiked to the side of the timbers in each ring. These cleats, of course, left a 2-in. space between the main bents which was filled in with 2-in. planks so that the entire section was boxed in solid on sides, floor and roof.

It was found necessary, in order to hold the section to the desired shape, to supplement the permanent timbering by temporary timbering. This scheme of internal bracing reduced to a minimum the possibility of collapse from external pressure and held the section approximately to its true shape until concreting could be started. The key-blocks in the arch segment were set 12 in. higher than the extrados of the finished concrete arch to allow for settlement.

The average progress in excavating and timbering in the compressed-air section was 25 ft. per week in the one heading. Conditions similar to those encountered in the Eastview tunnel were reported in the driving of the Croton aqueduct, 25 years ago. The Croton line is located about 2 miles west of the Catskill line and was carried through soft water-bearing material without the use of compressed air. The English system of crown-bar timbering was used and in his book entitled "The Water Supply cf New York City," Mr. Edward Wegmann reports an average progress of 1.4 ft per week. The contractors on the Eastview tunnel are convinced that the compressed air methods they have employed show marked advantages over the earlier open-air scheme used

in driving the Croton aqueduct in tunnel. It was noted at Eastview that when the air was applied it drove the ground-water back out of the sandy clay, so that the latter stood up well and caused no appreciable trouble during the work of excavating.

When the air was first applied an attempt was made to remove the material by hydraulic jetting, but the attempt was unsuccessful, for the material proved to be too hard to handle in this way after the water had been driven from it by the air pressure. In fact dynamite was generally used to loosen the heading and bench material.

The mucking was done with picks and shovels and the material loaded into low, narrow tunnel cars, designed especially to pass through an air-lock.

In the compressed-air section, a cable and an electrically-operated drum hauled the loaded cars from the heading and up a slight incline to the lock. The empty cars were coasted and pushed by hand on the return trip. From the south lock to the shaft and from the north lock to the north portal the muck cars were hauled by an electric trolley car which received current from an overhead wire.

### THE AIR LOCKS.

There are two air locks, one in the north and one in the south bulkhead walls. These are each 20 ft. long and 6 ft. in diameter. On account of the unusually large amount of timber to be taken into the tunnel a special timber lock was built, thereby leaving the regular locks clear for the passage of the muck and concrete cars. The timber lock is simply an 18-in. cast iron pipe, about 32 ft. long, extending through the concrete bulkhead to the left of the main lock.

In addition to the tunnel locks there is a hospital lock at the construction camp, equipped in the usual way for receiving workers afflicted with the bends. There has been little occasion to use a hospital lock, however, for the maximum pressure in driving, 26 lb. per square inch, and in lining, 21 lb. per square inch (this was the maximum pressure up to May 1), has not been high enough to cause any appreciable amount of sickness. The men work an eight-hour shift under air pressure and there are three shifts per 24 hours, the length of each shift being limited by the New York State labor law.

### COMPRESSED AIR PLANT.

The plant equipment for the compressed air work consists of an Ingersoll-Rand low-pressure compressor with a capacity of 1800 cu. ft. of free air per minute. This machine is run by a 50-hp. General Electric motor, operated on current purchased from the Westchester Lighting Company. There is also an auxiliary high-pressure compressor of 2400 cu. ft. per min. capacity, driven by a 100-hp. motor. This machine is located at the main power plant and was used for supplying air under high pressure to the drills in the rock section of the tunnel. The electricity is supplied at 13,000 volts and stepped down by transformers to suitable voltages for use in the motors.

### PLACING CONCRETE LINING.

The placing of the concrete lining in the compressed-air tunnel was begun on March 11, 1912. Air pressure has been maintained in the tunnel at from 18 to 21 lb. per square inch while the concreting was in progress.

The scheme of delivering the concrete to the forms involves the use of nine tunnel cars which are run upon a regular schedule so that three cars are always being unloaded at the form while three are being filled at the mixer and the remaining three are on their way either to or from the tunnel. The haulage is done by a narrow-gauge electric trolley car and the distance from the mixer to the air-lock is about 2300 ft. The cars are dumped onto the working platform from which the concrete is shoveled into the forms; when the cars are run through the locks the sudden application of air pressure tends to pack the concrete down, making the cleaning of the bottom of the cars troublesome.

The practice in concreting the north and south bends of the tunnel, where compressed air was not used, was to run the concrete cars up an incline on to a platform within the forms and near their tops and discharge the concrete directly into place. In the compressed air section, however, this scheme could not be carried out on account of the large amount of temporary timbering which obstructed the bore and made the use of an incline impossible. As a substitute means of carrying the concrete to the top of the forms an electrically-operated elevator was used. Vertical guides were bolted to the ends of the forms and cages were put in to receive the cars from the narrow-gauge track through the tun-

nel and raise them to the concreting platform in the form. This elevator is an integral part of the form and requires no resetting when the forms are struck and moved forward into a new position.—Abstract from *Engineering Record.*

## DEVICES OF VARIOUS PNEUMATIC INTEREST

Upon the oppoite page are assembled a number of sketches, taken from various contemporary sources, of pneumatic apparatus, or devices with which the air has something to do, which will doubtless be of interest to many of our readers.

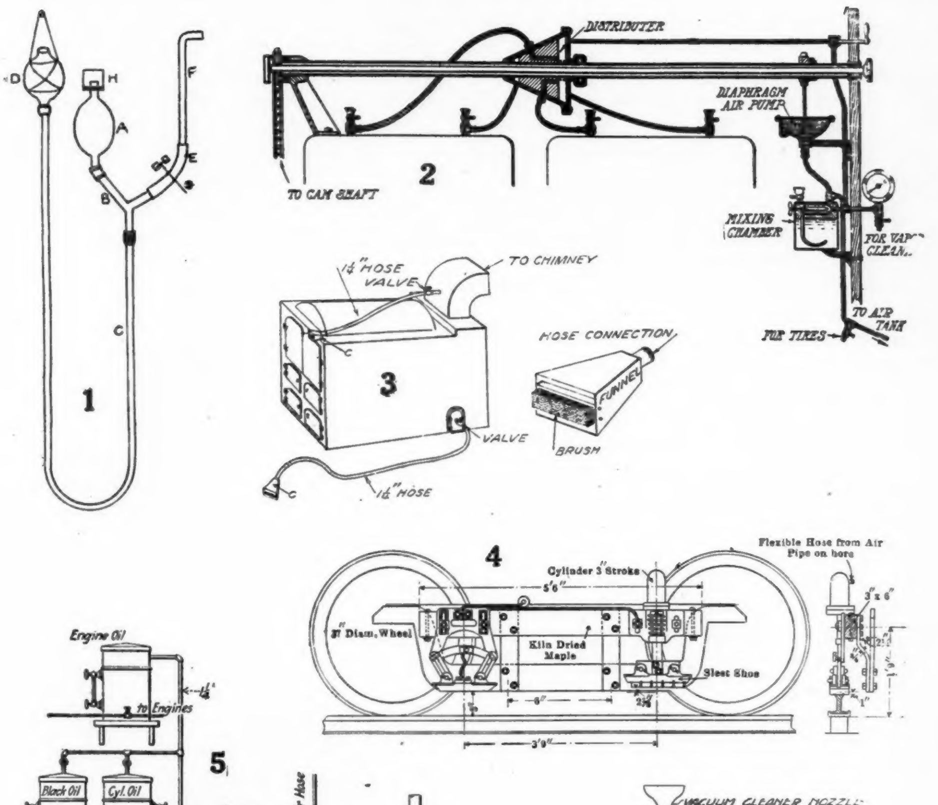
### A SIMPLE LABORATORY VACUUM PUMP.

No. 1 is from the *Model Engineer,* London. For all ordinary purposes, it is said, where a perfect vacuum is not required, the pump shown, simple in construction and action, will be found to answer well.

A glass bulb or large pipette, A, is connected by means of rubber tubing, with a small glass Y piece, B, to the lower limb of which is affixed a piece of thick-walled indiarubber tubing, C (known as pressure tube by chemical dealers, or acetylene gas tube by dealers in rubber goods). This, in turn, is connected with the mercury reservoir D, which may be another bulb tube, as figured, or merely a plain glass funnel. The former is preferable, as there is less chance of the mercury being spilt. The reservoir is contained in a cradle of bent wire with a loop at the top for suspension. In the selection of the bulb regard should be had to the quantity of mercury available. A 4-oz. pipette holds 54 ozs. of mercury, or allowing for the tubes, about 5½ lbs. would be required. But whatever the dimensions of the reservoir and pump-head (as the bulb A is technically known), the length of the rubber tube C remains the same, and should be 45 ins., excluding the portions lapped over the glass at either end. Communication with the receiver, or vessel to be exhausted, is made by means of the left-hand branch of the Y tube to which is fixed a short piece of pressure tube, E, connected at the other end with a piece of glass tube, F, bent at right angles. A simple substitute for a glass tap which has the advantage of not being liable to leak is shown at G. It consists of a piece of wood pivoted at one end and pulled downward toward the baseboard at the other end by a short indiarubber ring. If the pressure is properly adjusted by using a strong enough ring, the tube E will be kept closed, except when the free end of the lever is lifted for a moment while working the pump. It only remains to fit a valve, H, at the top of the pump-head. The several parts of the pump may be clamped to a stout pine board of suitable size, each part being supported on a small block of wood. The pump head will require a small bracket with a hole cut to take the curvature of the glass. It will be as well to make this a little on the large size and line it with soft leather or thick cloth. The other parts can be fixed with saddles made by bending a strip of brass in the middle and drilling holes in the ends. All joins between glass and indiarubber should be made by heating the glass till it just melts the rubber and pushing the latter on for about three-quarters of an inch. This makes a very firm joint, and dispenses with the necessity of binding on with wire, except at either end of the long rubber tube, where the joins are subjected to considerable strain. The reservoir being filled with mercury, it is raised until the metal flows up to the top of a pump head, the position being marked on the board and a stout hook screwed in to hold the reservoir on future occasions. It is then lowered until the mercury has fallen below the branch in the Y tube, leaving a torricellian vacuum above. Another hook may be screwed into the base to hold the reservoir in this position. The lever G should be raised for a second before raising the mercury again in order to allow the air to escape from the receiver into the pump head.

### THE BAUM AUTO-STARTER.

No. 2 shows an apparatus made by the Baum Brass and Model Works, Minneapolis. Compressed air operates it, the air being compressed by a diaphragm pump which has no piston and is operated by means of an eccentric from a hollow shaft, chain-and-sprocket driven from the cam-shaft. On this shaft is mounted a distributor, with leads to the pet-cocks of the cylinders. The air line is provided with a pressure-gauge, and leads to a conveniently located storage tank. A small knob on the dash is connected through the starter shaft, which is hollow, to a pin clutch, which engages the loosely revolving driven




VARIOUS PNEU MATIC DEVICES.

sprocket. Air is admitted to the distributor through a supply valve, controlled by a small lever on the dash, the air first passing through a mixer, which consists of a small gasoline tank of 1 quart capacity, in which is an adjustable saturated wick. In operation, the clutch-knob of the starter is drawn back and the pump and handle is next turned, admitting the explosive vapor into the distributor and thence to the cylinders. When the engine is started, the supply valve is closed, and the pump allowed to continue pumping until a pressure of 100 pounds or more shows on the gauge, when a push on the clutch-knob stops the starter-shaft from rotating, the chain and sprocket running idle. Air for the tires is obtained by connecting a few yards of tubing to the stop-cock below the mixer, and a gasoline vapor for cleaning purposes is obtained by connecting the tubing to the stop-cock below the gauge.

### A BOILER-ROOM VACUUM CLEANER.

A correspondent of the Practical Engineer sends sketch No. 3 which he calls a "natural" vacuum cleaner. He says take two old 1¼ in. gate valves and make a connection on the top of the boiler to the breeching as shown and get a light 1¼ in. hose long enough to reach the farthest dusty place on the boiler, connect the hose on the breeching and then put on the dust collector as shown at *C*. The little sketch at the right shows how to make the dust collector, only a funnel with a long-haired brush fixed in the end, with the hair extending from the end so as to sweep or loosen the dust.

### PNEUMATIC SLEET SHOE.

No. 4, from the *Electric Railway Journal*, shows a pneumatically operated sleet cutting shoe designed by W. Silvers, superintendent of equipment of the Michigan United Railways.

Each car is equipped with two of the pneumatically operated shoes attached to the front end of the third-rail beams on the front truck. The sleet-cutting shoe is of the same design as the regular third-rail shoe, but has four steel cutters set diagonally in its face and cast integral with the body of the shoe. The sleet-cutting shoe is mounted on a vertical iron shaft which passes through guides and is attached to the piston of an air cylinder which has a 5-in. stroke. A spiral spring around this shaft holds the shoe off the rail except when air pressure is put on the cylinder to press the cutters against the rail. The air supply is taken from the train line through a ⅜-in. three-way valve and pipes extending under the car to a point convenient for connecting with the cylinder which operates the shoe. This connection between the pipes and the cylinder is made with a 2½-ft. length of ⅜-in. air hose, secured at each end with hose clamps. An ordinary straight valve is placed in each supply pipe to enable the motorman to use one or both shoes as occasion demands.

### COMPRESSED AIR OIL LIFT.

No. 5, from *Power*, is a self explanatory sketch of an arrangement for transferring oil from barrels to engine room storage tanks. It is simple in construction and can be made in a short time (with the exception of a special bushing which requires lathe work) by any one familiar with pipe tools. An enlargement of detail at X is shown at the right. Care should be taken not to open the air valve too suddenly, especially when pumping cylinder oil, which is generally heavy and hard to move. It is best to let the cylinder oil stand in a warm place for a day or two before attempting to pump it out. A ¼-in. needle-valve on the air line should be used, but an ordinary valve will do if the attendant is careful.

### HOME-MADE VACUUM CLEANING OUTFIT.

No. 6, from the Electric Traction Weekly, shows a vacuum cleaning outfit got up and in use in the shops of the Ohio Electric Railway, Lima, Ohio. The shops of the company are equipped with a compressed air system, the air being used for numerous shop purposes and for blowing out motors, controllers, etc. Each pit is equipped with an air line carrying 80 lbs. pressure. A ½-in. pipe from this air line is narrowed down to a nipple with a ⅛-in. hole in the end which is thrust into one end of a 1¼-in. tee, the other end of the tee being connected with a refuse drain pipe leading to an ordinary gunny sack. Into the side of the tee is a ¾-in. pipe connected to a 1¼-in. suction pipe consisting of 40 ft. of hose and terminating in a vacuum-cleaner nozzle. The force of the air through the ⅛-in. nipple creates a sufficient vacuum in the suction pipe to thoroughly clean all surfaces to which the vacuum-cleaner nozzle is applied. It is found that a man can get over a 55-ft. car and do a good job of cleaning in 20 minutes.

PORTABLE FORGE WITH PISTON BLOWER.

A portable forge, made in England, in which the blast is supplied by a cylinder with reciprocating piston, instead of fan or bellows, is shown by No. 7. The entire body of the forge is used as an air reservoir whick makes the blast quite even. There is an ordinary tuyere the blast of which is controlled by a sliding valve. One or more gas blow pipe nozzles can be affixed to the top of the forge, and these can be turned in any direction.

SAND BLAST DEVICE.

An inexpensive portable sand blast device for occasional sand blasting is shown, only the nozzle portion, in No. 8. The air hose connects with the air supply which, to give the best results, should have a pressure of 80 to 90 lb. The suction hose leads to the sand pile or bin nearest the work, the best plan being to have as short a suction as possible. It is made by the Niagara Device Company, Buffalo, N. Y.

PNEUMATIC VALVE LIFT.

No. 9, from *Power*, is only to be regarded as a suggestion by a correspondent. It is a device for operating large valves, consisting of a cylinder *A* bolted to the upper flange on the valve body; a piston *B*, fitted to the upper end of the valve stem *C*, which is packed, as shown and a four-way cock *E* connected by means of unions to the cylinder *A*. The illustration shows the position of the piston when taking air underneath and exhausting above the piston *B*.

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## LIQUEFIED NATURAL GAS

BY DR. WALTER O. SNELLING.

It has long been known that during cold weather a liquid collects in the exposed pipes at many natural gas wells. At first the matter was regarded solely as a nuisance, since drip tanks had to be installed to separate the liquid from the gas, and when a considerable quantity of the liquid accumulated in the tanks they had to be emptied.

That the liquid which thus collected in the drip tanks was gasoline was probably recognized by many persons, but for a period of several years there appears to have been no realization of the significance of the fact, and practically no attempt was made to utilize the product. After some years of this waste, the collection and utilization of the gasoline seems to have come to the mind, at about the same time, of several men in widely separated localities. In the Pittsburg district the Robinson brothers appear to have been the pioneers in this development, and they made arrangements with the lessees of a number of gas wells by which they were allowed to draw off the liquid from the drip tanks and dispose of it for a part of the profit realized.

The gasoline which was thus obtained was a perfectly transparent and colorless material of very satisfactory grade. With systematic efforts to collect this material came the observation that different sources of natural gas differed greatly in regard to the amount of gasoline which was produced and the conditions under which it would separate. Natural gas which came from the earth under high pressure would seldom give a liquid condensate, even in the coldest weather, while the very heavy gases, which come from oil wells and which are under very slight rock pressure, would frequently give an abundant supply of gasoline. But with the coming of summer, as the temperature out of doors became higher, even the amount of liquid which collected in the best wells became greatly lessened. It was to regain the profit which was thus found to be slipping away that the earliest efforts were made at compressing and cooling natural gas in the efforts to separate from it the gasoline which it holds in the form of vapor.

It was found possible to prepare gasoline of excellent quality by simply compressing the natural gas in an ordinary air compressor and then passing the compressed gas through cooling coils, connected to a suitable drip tank, from which the separated gas could be drawn off. From the heavy or "wet" natural gas of oil wells it is not uncommon to get six or seven gallons of gasoline from each 1,000 cu. ft. of gas treated, and there are many gas fields from which three to four gallons of gasoline per 1,000 cu. ft. of gas may be obtained. Even with compression and cooling it is not possible to produce gasoline from natural gas, which comes from the earth under high rock pressure, and this is naturally to be expected, since such gas consists almost entirely of methane, and the natural

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*A paper read before the Pittsburg Section of the American Chemical Society.

pressure which exists in the earth has been sufficient to prevent its carrying any considerable amount of the heavier hydrocarbons. At the present time the industry of producing gasoline from natural gas has assumed large proportions; some hundreds of plants are already in operation, and the aggregate production has reached many thousand gallons per day; most of which is sold as a blended product composed of a mixture of refinery naphtha and natural gas gasoline, this blended product giving excellent results for all purposes for which ordinary refinery gasoline is used.

With the earliest attempts at utilizing the new gasoline, attention seems to have been called to the fact that it was in nature not identical with ordinary or refinery gasoline. Some natural gas gasoline contains dissolved gases to such an extent that when resting quietly in a glass vessel it effervesces or "boils" strongly, and gives off vapors so rapidly that the volume is greatly reduced by standing even for a period of an hour or so. That the vapors thus given off formed an explosive mixture with air was forcibly shown by a series of accidents which were associated with the early efforts in the use of natural gas gasoline. It was in the effort to find a means of separating from natural gas gasoline its dissolved gases that my first studies in connection with this subject were made.

Repeated efforts had been made to separate the dissolved gases by distillation. In many cases the gasoline produced at the compressor had been placed in steel vessels, heated by steam coils, and there warmed until a half or more of the gasoline had been evaporated. Even after this wasteful treatment the remaining gasoline was found to contain dissolved vapors to such an extent that it gave abnormal pressures when tested and gave off gases to such an extent as to be considered dangerous. Efforts were also made by some of the producers of natural gas gasoline to free their products from dissolved gases by exposing the material to the air in shallow tanks, and I understand that at one plant over 75 per cent. of the condensate produced was allowed to evaporate into the air in the effort to obtain a satisfactory product; but even in this extreme case the tendency of the vapors which escape to carry with them the heavier products, and the tendency of the heavier residue to still retain a portion of the dissolved gases, made this method not wholly successful, even after three gallons of condensate out of every four gallons produced had been allowed to go to waste in the air.

After considering the matter for some time it came to me as a happy inspiration to try to utilize the critical pressures of the different gases as a means for their separation. It is well known to physicists that there is for each gas a critical temperature, above which no amount of pressure, however great, will reduce it to a liquid condition. It seemed to me that by some suitable arrangement it ought to be possible to volatilize a mixture consisting of ethane, propane, butane, pentane and hexane, for example, and then under high pressure to introduce into such mixture a coil heated by means of superheated steam or hot water to such a temperature as to be above the critical temperature of ethane and propane, for example, but below the critical temperature of butane, hexane and pentane; and under these circumstances it seemed natural to suppose that the liquid which was separated by means of the coil would consist mainly of butane, pentane and hexane, and that the ethane and popane would be left as uncondensed gases, to be condensed as a subsequent operation. I carried out some experiments with this method and found it to be all that I had hoped. By means of a series of coils, heated to different temperatures intermediate between the critical temperatures of the different gases, I found it possible to fractionate the vapors from natural gas gasoline so as to obtain as one fraction gasoline equal in every respect to the best refinery gasoline, and this result was achieved without the loss of any of the original products.

The critical temperature of a gas is a physical constant and is not changed by pressure; and the selective condensation of vapors under very high pressure (up to 1,000 lbs. per square inch) upon hot coils in higher temperature than the critical temperature of part of the gases present promises to give important and valuable results not only in the preparation of liquid gas, but also in other refining operations. In its nature the new process of refining is entirely different from the ordinary method of fractionation by distillation.

The material which condenses upon the last coil in the series consists of ethane and propane, two gases which may be readily changed to the liquid condition by pressure and cooling, but whose boiling points under normal conditions of pressure are many degrees below 0 deg. Cent. That these gases, liquefied and contained in strong steel cylinders, would form an ideal illuminant, seemed evident, and I at once carried on further experiments to determine the possibility of so producing and utilizing them.

At about this time my attention was called to the work which was being done by Frank P. Peterson, of Grove City, Pa., and of C. L. Kerr, of Pittsburg, Pa. Both of these gentlemen were making efforts to harness the enormous supply of energy which was slipping away in the form of wasted natural gas. Mr. Peterson had made successful efforts to condense the lighter gases remaining after the separation of gasoline from natural gas, and to obtain a liquid product which he believed might be suitable for use as a substitute for Pintsch gas in the lighting of cars; and Mr. Kerr and his cousin, A. N. Kerr, had also carried out experiments along a somewhat similar line. We all realized that the problem, which we had each approached from a different angle, was capable of solution by the joint methods which had been worked out; and, making use of the liquid product produced through the stage-compression method of Mr. Peterson, I found it possible to effect, by the method which I already explained, a complete rectification of the material, thus obtaining a liquid gas which could at all times be produced of uniform quality and without the waste of any portion of the original gas.

The results which had been obtained are now so well known that it is not necessary for me to refer to them in detail. Tests made with great care have shown that it is possible to produce from natural gas, by a combination of the methods of stage compression and rectification, not only gasoline of the most excellent quality and equal in every respect to the best grades of refinery product, but in addition to recover all of the ethane, propane and butane, as a liquid gas, in such a form as to make it a convenient, safe, clean and cheap method of lighting isolated dwellings, such as country homes, seaside resorts, lighthouses and light buoys, etc.

For many years the waste of natural gas in the United States has reached enormous proportions. Dr. I. C. White, State Geologist of West Virginia, has in particular called attention many times to the enormous extent to which natural gas and oil well gas was being allowed to escape, with the consequent loss to the nation of the equivalent in heating power of many millions of tons of coal.

This waste no longer seems necessary, since it is these very gases from oil wells which have up to now been the most difficult to utilize in pipelines, etc., that are best adapted to the production of liquid gas and gasoline by the new methods. Plans are already under way to utilize some millions of cubic feet of gas daily in the production of gasoline and liquid gas, and thus to add decidedly to the national supply of both gasoline, a material which is finding each day ever-widening uses, and liquid gas, a product which seems destined to play a large part in the lighting of isolated dwellings.

The name "Gasol" has been given to the liquid gas produced by the new process. When under a pressure of 500 pounds to the square inch it exists as a clear, transparent liquid. When the pressure is lessened it changes into gas, and at normal or atmospheric pressure this gas is, unlike the gas produced by blowing air through gasoline, for example, extremely dry, and does not give any liquid condensate in the pipes, etc., all of the hydrocarbons which so condense having been separated in the process of rectification and going into the gasoline product. One volume of liquid Gasol produces about 250 volumes of gas upon release of pressure, and the gas so produced has a heating value of about 22,000 calories per liter, or about 2,400 B. t. u. per cubic foot. When it is remembered that the heating value of ordinary coal gas is only about 600 B. t. u. per cubic foot, and manufactured oil gas is less than 650 B. t. u. per cubic foot, it will be seen that the new gas has about four times the heat producing capacity, when equal volumes are considered, of either coal gas or manufactured oil gas. In addition, its flame temperature is much higher, being decidedly higher than the flame temperature of natural gas or any other of the common gases used for heating. The flame temperature of ordinary natural gas burning in air is about 2,150 deg., and the flame temperature of ethane burning in air is about 2,205 deg. The flame

temperature of the new gas is about 2,300 deg., and since the amount of light produced from the Welsbach mantle bears an important relation to the temperature of the flame, the reason is here seen for the remarkable brilliancy of the light produced by the new gas, which excels in this respect all gases previously known.

It must be remembered that the preparation of liquid products from natural gas is itself not new, and liquid gas has been prepared for years from oil by destructive distillation, and also from coal and from natural gas. In connection with the preparation of a high-pressure liquid gas from natural gas, Frank P. Peterson has made important inventions, and C. L. Kerr, A. N. Kerr, T. G. Phinney and others have done very important pioneer work. The new process of preparing a liquid gas of perfectly homogeneous nature and uniform composition is the culmination of the work of many men, and of several years of experimenting. It opens to the use of the world the enormous volumes of oil well gas now so generally wasted, and produces from this waste material a product which gives to the country home all of the conveniences of gas for lighting and cooking, thus giving to the farm advantages which have been up to now available in general only to the city.

## PHYSIOLOGICAL EFFECTS OF CO.*

An interesting pamphlet on carbon monoxide has recently been issued by the Bureau of Mines, in which attention is drawn to the dangerous properties of this gas and to the use of mice and birds for detecting its presence in mine air. The author quotes largely from various publications of Dr. J. S. Haldane of Oxford University, who for many years has made special study of the subject of mining hygiene and the dangerous gases met in mines. The author states (p. 6): "According to Haldane, carbon monoxide has no other effect than that resulting from its interference with the oxygen supplied to the tissues, and apart from its property of combining with the hæmoglobin it is physiologically indifferent, like nitrogen." The author also outlines an experiment in which he remained for twenty minutes in an atmosphere containing 0.25 per cent. of carbon monoxide, "at the end of which time he suffered only a slight headache, although later he became ill. The illness lasted for several hours and was accompanied by nausea and headache." The quotation from Haldane, and this experiment, are likely to give a false impression as to the dangerous properties of this gas; it has therefore seemed wise to give a few facts that others may not be led to repeat the experiment made by the author of the pamphlet, and to give some idea of the dangerous nature of this gas even when present in very small amount.

Carbon monoxide is a product of incomplete combustion. It is present in large quantities in producer gas and water gas, and in dangerous amounts in the gases from boilers and furnaces of all kinds. It is often present in large proportions, and always in dangerous amounts, in powder smoke, in the gases from underground as well as surface fires, and in the afterdamp from explosions of firedamp and coal dust.

### CO MAKES HAEMOGLOBIN INERT AS AN OXYGEN CARRIER.

Carbon monoxide has the property of forming a compound with the hæmoglobin of the blood. The effect of this is to make the hæmoglobin, so combined, practically inert and to prevent it from acting as a carrier of oxygen. When so much carbon monoxide is absorbed that the greater part of the hæmoglobin is inert, death results. The affinity of carbon monoxide for hæmoglobin is more than 200 times greater than that of oxygen, so that when present in the air, even in small quantities, it is freely absorbed by the blood. Carbon monoxide is not displaced by oxygen but is dissociated by natural processes, and escapes in the expired air. Where large quantities are absorbed, it may be several days before the last traces disappear. According to Doctors Edsall, von Jaksch, Haldane, and other authorities, 0.05 per cent. of carbon monoxide is dangerous. According to Haldane, sever symptoms were observed from breathing air containing 0.02 per cent., or one part in 5000. With this small amount present the blood becomes 20 per cent. saturated after about 20 hr., producing slight giddiness and shortness of breath. At this point an equilibrium seems to be established, and the dissociation of the gas keeps pace with its absorption. With in-

*Professor Henry S. Munroe in School of Mines Quarterly.

creasing percentages of carbon monoxide, the saturation of the blood becomes greater and the time required to produce the maximum effect shorter. With 0.08 per cent. present, the blood becomes 50 per cent. saturated within a few hours; it becomes scarcely possible to stand and even slight exertion results in loss of consciousness, the sense are confused and the judgment is impaired. Sometimes the victim either becomes stupid and drowsy, or much excitement results, not unlike the effects of alcohol. Another experiment by Doctor Haldane proved that with 0.20 per cent. CO in the air the blood becomes 50 per cent. saturated in 70 min. With 0.25 per cent., the amount present in the Bureau of Mines, experiment, this dangerous condition would be reached in less than one hour.

### CO PRODUCES CONGESTION IN THE VITAL ORGANS.

According to von Jaksch, the absorption of 0.8 gram of carbon monoxide is fatal. According to Haldane, if death occurs gradually the hæmoglobin is usually about 80 per cent. saturated with carbon monoxide. Post-mortem examinations of persons who have died from carbon monoxide poisoning show that the effect is to produce intense congestion of the vital organs, especially in the brain, usually accompanied by small hemorrhages. It is possible that this congestion is due to the attempt of nature to make good the diminished efficiency of the blood by supplying larger volumes at needed points.

Even when death does not occur, serious results are likely to follow from the absorption of this gas by the blood. The after effects are lesions, cysts and local softening of the brain tissue, inflammation of the membranes of the stomach and intestines, pneumonia, bronchitis, pleural effusions, inflammation of the kidneys, fatty changes in the heart, ænemia, splenic enlargement and other derangements of vital organs, sometimes resulting in death even after several years. It is believed that Sir Clement Le Neve Foster was a victim to carbon monoxide poisoning which occurred on a visit as chief inspector of mines to a mine in Cornwall a few years before his death. From the full record given by Mr. Foster of his symptoms while exposed to the gas underground it does not appear that there could have been more than 0.08 per cent. of carbon monoxide present, nor that his blood could have been more than 50 per cent. saturated, although direct evidence on both these points is lacking. The experiment made by the author of the paper recently issued by the Bureau of Mines, in which he exposed himself for 20 min. to an atmosphere containing five times as much carbon monoxide as is known to be dangerous, was therefore hazardous and even though the experimenter apparently suffered but little ill effect a somewhat longer exposure would certainly have resulted in serious injuries, the after effects of which might have proved fatal.

### MINERS' PHTHISIS FROM CO POISONING.

One of the most serious dangers from the presence of carbon monoxide in the air of mines is the effect upon the health of workmen who are daily exposed to the breathing of small amounts of this gas. The blood, when partly saturated, is thereby rendered less able to perform its proper functions, so that the patient suffers from ænemia and all the complications that may result from this weakened condition. According to Doctor Edsall, the disease known as miner's phthisis has been shown to be due chiefly to carbon monoxide poisoning. Recent observations have shown that for some hours after a blast, under the conditions of ordinary mining, carbon monoxide may be present in the air in dangerous amounts, and undoubtedly the blood of men engaged in sinking, drifting, and stoping where the circulation of air is deficient is partially saturated with carbon monoxide the greater part of the time.

### EFFECT OF CO IS CUMULATIVE.

By some authorities it is believed that the serious effects above outlined, due to absorption of carbon monoxide by the blood, are supplemented by direct toxic action on the nervous system, on the muscles, the heart and other organs. It is believed by others that there is a cumulative action and that those who have been poisoned by this gas are more likely to become victims when again exposed to it. It is quite certain that dissociation of carbon monoxide from the blood is slow and that those whose blood is partly saturated will sooner fall victims where larger quantities of the gas are breathed than those whose blood is free from this gas. Men who have repeatedly suffered from carbon monoxide poisoning become very sensitive to the gas, and in most instances are compelled to abandon work in which they are compelled to breathe air containing it.

MANIFESTATIONS OF CO POISONING

The symptoms by which carbon monoxide may be detected are not difficult of recognition. The blood becomes a brilliant cherry-red, and in serious cases red or bluish-red spots appear on the front of the neck, on the trunk, thighs and elsewhere, lasting for some days, and in fatal cases apparent after death. The mental disturbances, weakness and lassitude, have been noted. This is followed by headache, accompanied by nausea, often lasting 24 or 48 hr., even in slight cases. In more serious cases, headache may recur at intervals for some months. Loss of consciousness with convulsions, may occur several hours after the poisoning. One of the first symptoms is weakness in the knees and legs, sometimes lasting for days, with aching from the knees to the ankles. Local pains in the region of the heart, and palpitation of the heart, are common and may recur at intervals for a month or more. Foster, and several others, have published valuable notes on these symptoms, which will be found in the appendix of Foster and Haldane's "The Investigation of Mine Air."

## HANDINESS OF COMPRESSED AIR

A writer in the Southern Engineer calls attention to the variety of compressed air employments in pumping stations. In one station, he says, there are no less than eight different applications of compressed air, while in other stations the number of uses is sometimes greater than this. The station referred to contains triple expansion crank and flywheel pumping engines. Compressed air is needed on the discharge side of these pumps as a cushion. Air is generally forced in by means of a small electrically driven compressor when starting the pumps. After starting it is sometimes found necessary to diminish the cushion, because of the air that is carried over with the water from the suction well. This air, under a pressure of 70 pounds, the pressure maintained in the water mains, is also used to close the exhaust poppet valves on the intermediate and low pressure cylinders, a sufficient amount of air being maintained in the air chambers of these pumps by self-contained air compressors.

The oiling system of this station is operated by compressed air taken from the air chambers. There are two galvanized tanks capable of standing the water pressure, each being of sufficient size to supply the station for about eight hours. One of the tanks is filled with oil, and air under 70 pounds pressure applied thus forcing the oil wherever needed. The return oil is led to a filter and from the filter it flows into the second tank. When the first tank is almost empty, air pressure is applied to the second or full one, and pressure taken off the one that is nearly empty.

Compressed air is used to pump water by means of an air lift from an artesian well into a large tank above the boilers. The compressor supplying air for the air lift also supplies air for pneumatic hammers, blowing out electric generators and for blowing the superheaters. Compressed air has also been used in place of the steam jet in conjunction with the Roney stokers.

In the water purification department compressed air is used in large tanks which store sufficient water to wash the filters. These tanks are strong enough to stand the full pressure of the large pumps and when empty contain about 16,000 cubic feet of air, which, when the tanks are filled, is compressed into a smaller tank above. The air is then used for agitating the iron and soda solutions required in the process of filtration and purification.

Wherever air is used it is evident that steam would not do as well if at all. For instance, the lift from the surface of the water in the artesian well is over 100 feet, and to install a pump capable of raising water from the well would be very costly, especially when compressed air is so conveniently at hand and obtained so cheaply. Steam also would not work as smoothly as air in the closing of the low pressure poppet valve.

## EXTINGUISHING A FLAMING GAS WELL

There are various tricks resorted to for extinguishing blazing gas wells. A well at Lone Pine, Pa., with an 8 in. casing and a capacity of 5,000,000 cubic feet a day, was struck by lightning recently and the flame lighted the country for miles around, while the heat was so intense that operations near by were impossible. After three days a very simple device gave quick success. By the aid of long ropes a boiler stack, with a base mounted on rollers and guys to keep it upright, was moved over the well, the flame then raging at the top of the stack. A sudden jerking away of the stack made a break in the gas current and the flame went out instantly.

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## DON'T WORRY ABOUT THE ATMOSPHERE

Collective humanity, like the individual man, creates for itself—makes out of nothing—many unwarranted worries. Our supplies of coal and iron are going to give out, and what will we do then? Our earth-drawn nitrates for fertilizers are apparently much nearer exhaustion than coal and iron, and now that we turn directly to the atmosphere to abstract a supply a new worry is invented. What will we do when the air fails us?

It is proper to remember that we are not as big in comparison with the earth and its appurtenances as we are apt to think we are, and we have little power to disturb its established arrangements. We may say that—in very round numbers—the total weight of the atmosphere is 5,000,000,000,000,000 tons. That woud be—in the same style of numerical rotundity—3,850,000,000,000,000 tons of nitrogen and 1,150,000,000,000,000 tons of oxygen. Now, suppose that we abstracted a million tons, or a hundred million tons, of either how much would they be likely to be missed?

As a matter of fact we are mechanically abstracting from the atmosphere very small quantities, comparatively, of both nitrogen and oxygen, and these abstractings may so balance each other that the relative proportions of the two in the atmosphere as a whole may be little disturbed, but even this need not imply that we are reducing the total mass of the air by the amount of its constituents which we take from it by our modern mechanical manipulations. Whatever we seem to get we cannot get away with an atom of it. We can at the most only borrow, and our borrowings are "returned to stock" in spite of us.

We have to remember nature's automatic and constant restorative processes. The wonderful increase in our industries in the last hundred years has entailed the burning of coal, and now oil, in vast and increasing quantities, and this results in throwing off into the atmosphere incalculable volumes of carbon dioxide, and this alone might ultimately render life on the earth impossible, only that the process does not end with our doings. As we increase the burden of carbon dioxide in the atmosphere by all this active combustion, in addition to the slow combustion in our lungs and those of all breathing animals, we stimulate plant life by which the carbon is digested out

and the oxygen is returned to the air to act as a carrier or go-between over and over again.

It may be safely assumed that the more carbon dioxide there is in the air, the more rapid and luxuriant will plant growth become, especially the rapid growing annual plants upon which we depend for food, these in the aggregate presenting vastly greater air contact surfaces than do the more impressive tree structures. So far as we can see, the result of artificially increasing the production of carbon dioxide, thus stimulating plant growth, is beneficial to the human race rather than otherwise.

If the matter is sufficiently looked into it will be found that nature's processes provide also for the restoring of nitrogen to the air if by any other agencies it may be abstracted, so that the balance of atmospheric constituents is maintained from this side also. It is a curious thing that nitrogen, the larger component of the air has been less minutely investigated, and the ramifications of its functions are less definitely known than those of oxygen.

It is well understood that plant growth persistently abstracts nitrates from the soil, and that in successful agriculture these must be artificially replaced, but it is coming to be recognized that there are certain plants which add to the nitrate constituents of the soil, so that these may be made to assist each other; and the further we go in our investigations the more do we discover these automatic compensations.

So far as we may think we decipher at all the ultimate plan of things we may well believe that the atmosphere is made for free and universal use, that any human being may do with any portion of it whatever he will, that the entire human race may do the same, getting whatever benefit and satisfaction they can out of it without the slightest occasion for self reproach or anxiety as to any damages that may be entailed. Fresh air, pure air will always be accessible to us all whatever we may do to impair it, if we only go a little way from our crowded haunts.

## PNEUMATIC TOOL GENERALITIES

We have to take our mechanical inventions in the order in which they come to us, and we do not always get first the thing that is most wanted. The great opportunity for the use of compressed air as a relief and helper in the most exacting details of manual labor in the shops was long ago recognized, though perhaps few realized at first how much it would be able to do for us.

The most tedious and fatiguing of the workman's tasks have been eliminated, and at the same time his output has been increased and improved, but neither he nor his employer has had much choice as to the tools that should be first provided and has had to take them in the order in which they have happened to come.

In the getting up of air operated tools for the shop, or for portable use anywhere, why should the percussive tools have so long preceded the rotative tools when the latter form so large a portion of the tools normally employed? If any regard was had to actual practice, and to the demand which might have been predicated from it, the percussive tools and the rotative tools should have been started out together, or, if anything, with the latter somewhat ahead. Not only is there a great demand for handy rotative power for drills, taps, reamers, for grinding-in valves, for tube beading, for wood augers, for emery wheels when carried to the work, etc., but the number of these operations is continually increasing, while chipping and work of that character tends rather to decrease.

Well, the rotating drill, or drill driver, has arrived and, as usual, it has not come by the most direct route. There is perhaps nothing more common, and at the same time more curious, than our persistent placing of the cart before the horse in the process of developing our mechanical and other inventions. The more obvious arrangement of the horse before the cart is generally the last to be arrived at, and simplification taxes ingenuity more than complication does. The most perfect and effective contrivances we produce are ultimately the simplest, but the simplicity is only attained after complication upon complication have first been devised and adopted and then have been tediously eliminated.

We like to make a fuss in our doings whatever they may be, and mechanical fuss or complication has its attractions for us. Some things seem to get a start in popular estimation from the beginning just from the imposing array of details they present. The very size and the full war panoply of Goliath assured him of victory in advance, but the smooth

stone from the brook and the shepherd's sling scored the knockout.

The rotative drill, as now simplified nearly to perfection, makes very complete the pneumatic kit of the metal worker especially, so that it is now difficult for the inventor to find any more wants to fill in that direction. What more, for instance, can be done for the boiler maker? Only a quarter of a century ago his trade was one consisting of hand operations almost entirely, and now there is scarcely any hand manipulation—if we are permitted the tautology—left for him, while his former wonderful manual dexterity in riveting is becoming one of the lost arts, lost for want of exercise on the one side and for the lack of any market for such skill on the other.

With air hoists and jacks to begin with, the complete line of pneumatic hammers, riveters, chippers, caulkers, and then the rotative tools for the other operations, the trade once so dependent upon manual skill is now most independent of it.

Perhaps nothing so wonderful and complete in trade transformation as this, or accomplished in so short a time, can be found in history, and the effective agents have been the series of devices comprised between the air compressor and the little rotative drill.

## NATURAL GAS TRANSMISSION AND DISTRIBUTION

For the following sketch of the Cincinnati natural gas service we are indebted to Mr. Wm. A. Miller, General Manager of the gas department of the Union Gas and Electric Company, Cincinnati, Ohio.

Natural gas from the Ohio fields has been supplied by the Company since October, 1908, to that portion of Cincinnati, Norwood and adjacent villages north of the line of McMillan Street, and to all of Cincinnati, Norwood, adjoining villages, and Covington, since July 1st, 1909. The pipe line from near Culloden, W. Va., to Cincinnati, was completed and natural gas supplied through it ( as stated) July 1st, 1909, since which time the service has been uninterrupted to all of our domestic customers.

The pipe line referred to, consists of 123 miles of 20-inch seamless steel pipe, extending from Cincinnati to the Big Sandy River Compressing Station, and 33 miles of 18 inch seamless steel pipe, extending from the Big Sandy River to the end of main line near Culloden, W. Va. From the 18 inch main pipe line there are about 40 miles of lateral 12 and 8 inch pipe lines extending to, and penetrating the gas fields which embrace about 300,000 acres (the latter the property of the Columbia Gas and Electric Company) on which there are now drilled about 100 gas wells having an open flow of approximately 200 million cubic feet per day. These wells are, in the opinion of the Company's Engineers, capable of supplying the city of Cincinnati and adjacent villages and towns, for more than 30 years.

The West Virginia Pipe line, used in connection with our storage holders (having a capacity of 10 million cubic feet) is capable of transporting to our consumers upwards of 75 million cubic feet of gas daily, with an initial pressure of 320 pounds at Compressor Station, and a terminal pressure of about 60 pounds at Cincinnati. The distribution system of the City of Cincinnati and villages adjoining, consists of about 45 miles of belt line in the form of a figure 8, outlining the whole territory to be supplied, upon which a pressure of from 3 to 5 pounds is maintained, varying with the demand for gas and temperature of atmosphere.

From the belt line the gas is caused to pass through forty-two district regulators set in masonry pits, and located in streets in different parts of the City and villages supplied, which are adjusted for maintaining a pressure of 5 ounces on their outlets. The outlets of the regulators are connected to our low pressure system of mains, consisting of about 650 miles of all sizes of main pipes, from 4 to 30 inches in diameter. Individual house regulators are only used where the belt line is the only main from which a supply of gas can be obtained for the customer to be supplied.

## CARRARA QUARRYING METHODS

Consular Agent Felix A. Dalmas, Carrara, Italy, sends an interesting account of the marble quarries there and the methods of working. As will be noted, compressed air and the channeling machine are both conspicuously absent.

### CAUSES OF SLOW DEVELOPMENT.

The jagged, rough, precipitous character of the Apuan Alps and the peculiar geologic formation of the deposits, which can be expres-

sively likened to a tortuous, broken puzzle, difficult of access, account in a great measure for the slow and unique manner in which the Carrara industry has developed as compared with the marble industry, in America. But the main reason for the slow development and improvement is the lack of unity on the part of the quarry owners and the extreme individualism indulged in instead of cooperating for the conservation of the natural resources and the improvement of the industry.

It can not be denied, however, that a strong effort is being made toward conservation and economy of operation on the part of the larger Carrara firms and a few progressive quarry owners who thoroughly understand the situation and desire to improve the industry, but their problems are not easy. Yet, wasteful as the methods have been in the past, the last few years have brought great improvement.

With no other tools than sledge and wedge the Etruscans, two or three centuries before the Christian era, split the marble from the low, outcropping strata by main force. They were followed by the Romans, who continued the industry intermittently until the fall of their Empire. After that the quarries were probably forgotten. For centuries, so far as is known, no marble was quarried. With the religious awakening and fervor of the eleventh and twelfth centuries a great demand for marble was created, which, followed by the artistic activity of the fifteenth century, gave the industry an impetus which has lasted to the present time.

QUARRYING METHODS.

It is doubtful if there was any great improvement over the original methods of quarrying until blasting powder was invented and used. This wasteful process, by which hundreds of tons are displaced at one time, is still in use to a great extent, although it is being rapidly replaced, wherever possible, by the endless, spiral grooved wire, which is usually about 500 meters (1,640 feet) long, working tightly stretched over a system of pulleys attached to standards, two of which, fitted with automatic pressure screws, are placed on either side of the section to be cut. Hard sand, brought especially for the purpose from near Viareggio, is mixed with water and allowed to flow in a steady stream under the rapidly moving wire. This produces a clean cut. The 500-meter wire working at full capacity will cut a surface of approximately 700 square feet in 48 hours, and consumes in that time 9 metric tons of sand.

Electric power is generally employed in the quarries, but there are a few gas and oil engines in use and five small hydraulic power plants. The total horsepower employed in the quarries is 635 electric, 70 hydraulic, 42 steam, 168 gas, and 81 oil.

THE PENETRATING PULLEY.

A few years ago a new Carrara invention called the penetrating pulley was put into use, and this proves of great advantage where cuts are made in a solid floor, thereby eliminating the need of sinking more than one shaft or channel. Simply explained, the penetrating pulley is a thin steel disk with a shallow grooved edge around which the spiral grooved wire passes and projects beyond the edge. The pulley is rigged with a swivel on the end of an automatically operated screw; which is supported by struts and braces that are wired to rings firmly embedded in the floor in order to resist the downward pressure of the screw. A 1½-inch hole, to admit the screw, is first drilled to the desired depth. This acts as a lead to the disk which forces the projecting and rapidly moving wire into the marble.

The penetrating pulley can be worked at only one corner of a desired cut. At the other end an ordinary standard must be rigged, after first digging a channel in from the face of the cliff. In this way masses of marble containing as high as 5,000 cubic feet and weighing approximately 390 metric tons are cut loose. To displace this mass a wedge-shaped section, the apex terminating at the point of gravity, is cut from the base; a small charge of blasting power exploded in the rear cut tips it over, where it can be divided as desired. This manner of quarrying eliminates the necessity of squaring up the blocks, as is the case when the marble is blasted loose, and is naturally very economical. The penetrating pulley may now be said to be in general use. In 1911 pneumatic drills were installed in a few of the quarries.

One of the most serious problems for the quarry owners to contend with is the enormous quantity of waste that has accumulated for centuries. It often so interferes with the operation of a quarry as to make the work unprofitable. The encroachment of waste from a neighboring and higher quarry is a

frequent cause for litigation to decide priority rights, and as a consequence many good properties have been lost and many quarries are closed by force of injunction.

### EXPORTING WATER POWER

The main factor in obtaining a cheap supply of carbide of calcium is of course the power, so that the carbide industry has become localized near sources of cheap water power. At the same time the carbide produced is mostly used in widely distant localities and often in other countries, and in the latter case the exportations are if not of actual water power at least of most direct products of it. In the table below it will be seen that of the product of Sweden and Norway 92 per cent. is exported; of Switzerland, 86 per cent., and of the United States 26 per cent. At the same time Germany imports 80 per cent. of the total amount of carbide it uses; England, 87 per cent., and other countries, taken in a lump, 92 per cent.

| Countries. | Made. | Used. | Exported. |
|---|---|---|---|
| Sweden and Norway | 52,000 | 4,000 | 48,000 |
| United States | 50,000 | 37,000 | 13,000 |
| France | 32,000 | 31,500 | 500 |
| Switzerland | 30,000 | 4,000 | 26,000 |
| Italy | 28,000 | 23,000 | 5,000 |
| Austria and Hungary | 22,500 | 17,000 | 5,500 |
| Canada | 12,000 | 8,000 | 4,000 |
| Spain | 18,000 | 16,000 | 2,000 |
| Germany | 7,000 | 36,230 | ........... |
| England | 2,000 | 16,000 | ........... |
| Other countries | 5,200 | 63,800 | ........... |

### DOES OXYFEN GRAVITATE DOWN THROUGH THE AIR

It is quite generally understood that compressed air delivered by the Taylor hydraulic compressor has less than the normal proportion of oxygen. In an interesting article in a recent issue of *The Engineering and Mining Journal,* describing the Buffalo Mine at Cobalt, Ontario, which is supplied with compressed air from a Taylor hydraulic compressor, the following occurs:

"When this air was first introduced some trouble was experienced, as candles would not burn in close stopes where it was used. By driving a raise in these close places the trouble was overcome and now candles are used except in one or two especially long drifts where carbide lamps are necessary. While the lack of oxygen in this air caused trouble with the candles no ill effects are noticed by the miners nor have any of them suffered any effects since its introduction over two years ago."

Oxygen is one-tenth heavier than air while nitrogen is one-twenty-fifth lighter, and air is not a chemical compound but a mechanical mixture. From the experience outlined in the above paragraph it would appear that the oxygen is affected more or less by gravity so that with the raise spoken of, giving vertical depth to the body of air, the oxygen may settle down through it more or less while the nitrogen would correspondingly rise, with the improvement or enrichment of the lower strata as noted.

### NOTES

The belting used in the Baku (Russia) oil fields is principally that made from camel's hair; the leather, rubber and cotton belting does not withstand the action of the oil so well.

For nine months ending March, 1912, there were exported of napthas and other lighter products of distillation of natural gas 102,722,964 gals., valued at $8,763,619; in 1911 the figures were for the same period, 69,467,943 gals., valued at $6,163,525. For the same period in 1910 the figures were 49,041,971 gals., valued at $3,930,912.

Inventions are constantly outrunning each other. There is much complaint now that drill steel does not stand up to its work. It does not appear that the quality of the steel has deteriorated, but that more is required of it to meet the conditions of modern drills which have been greatly improved in intensity of operation and mechanical efficiency.

A serious explosion, causing the death of one person, occurred on the steam yacht Cristina in New London harbor. The owner is sure that no explosives were on board, and an explanation suggested is that hydrogen liberated from the electric storage batteries, which were in a tight compartment aft, mixed with air and that the mixture was ignited by a spark.

It is reported that the Turkish council of state is studying a plan for an underground the Golden Horn. A more ambitious plan, railway to connect Stamboul with Pera, under which English engineers are said to have in

hand, contemplates a double tube under the Bosporus, between the extreme points of Stambul and Haidar Pasha, to connect the railway systems of European and Asiatic Turkey.

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"It is stated" that the active officers of the Siamese Army have agreed voluntarily to forego a portion of their pay for 12 months in favor of the establishment of a fund for the purchase of heavy guns. And what will they do with the guns when they get 'em?

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Moving pictures are to be used by the Central Georgia Railroad to teach the elements of railroading to the more ignorant of the employes, many of whom are illiterate. It is believed that by substituting pictures for textbooks they can be taught to perform their duties more intelligently. Almost every detail of train operation can be shown effectively on the screen, and the pictures can be run over as many times as may be needed to teach the processes thoroughly.

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When slime is treated with sufficient lime to neutralize the ferrous sulphate and sulphuric acid the former is precipitated as ferrous hydroxide, which at once absorbs all the oxygen in the slime, and only a small percentage of which is changed into ferric hydroxide. Air lift agitation quickly introduces more oxygen, and at once changes the ferrous hydroxide into ferric hydroxide, and introduces the excess of oxygen, which is necessary for perfect conditions in cyaniding.

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The world's largest Curtis steam turbine, which drives an electric generator in the Waterside station, New York, develops 30,000-h.p. If it takes twelve men to equal 1-h.p., then this turbine engine develops twelve times 30,000, or the working energy of 360,000 men. If these men worked in eight-hour shifts each day, it would require the services of 1,080,000 men every twenty-four hours to produce the working energy of this single turbine unit.

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The empty gasoline or kerosene can is a blessing to the denizens of the desert. Four of them filled with water make just the right load for a jackass. One holds just a dime's worth of water. Split endwise, a bachelor's dishpan is the result. An experienced housekeeper cannot do without them. Cut the top out of one and you have a vessel just the right size to boil a ham. Cut around three edges of one and you have a box with a door, which mice cannot molest. If the roof leaks cut up an oil can and patch it. If you want an ash pan, cut one in two and there you are. Partly fill half of one with ashes and you have a spittoon.

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Injecting pure oxygen gas into the blood of airmen and mountain climbers, as an auxiliary supply to that inhaled into the lungs, is a remarkable means proposed for the prevention of the so-called mountain sickness, which is due to the rarity of air at high altitudes. The preventive treatment, which was described together with the experiments confirming its efficiency at a recent session of the French Academy of Sciences, consists simply in the subcutaneous injection of small quantities of pure oxygen gas, the effect of which is claimed to persist for several days.

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In the Fourth of July contests this year Page and Pickens at Tonopah drilled 45 7-16 inches in Rocklin granite in 15 minutes. Lundquist and Dahlen, of Victor, Colorado, drilled 41 7-16 inches, and Porter and Goddard, of Oatman, Arizona, 38 7-16. At Lowell, Arizona, a shoveling contest was held, the task being to shovel two tons of ore over a partition three feet high. The prize of $100 was won by Henry Arnes, who completed the task in 8 minutes. His nearest competitor, Frank Travers, was 26 seconds slower. The motion study sharps could take hold here and show these men how.

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In the vicinity of Newman, Cal., an energetic young man who believed that vacuum carpet cleaners could be sold in the country as well as in the city is responsible for the death of millions of grasshoppers in that city, and many alfalfa ranches whose parlor floors boast no carpets, have become his patrons. Noticing the desperate expedients made to rid gardens of grasshoppers he mounted a cleaner on a light sled and pushed it before him on the alfalfa. The hoppers jumped before it as it reached them and were drawn by the suction into the machine. The farmers have added to the economic advantages of the system by drying the hoppers and sacking them for chicken feed. So they say.

The Baldwin Locomotive Co. has been accumulating land for some time at Ridley Park, Pa., near its Eddystone works, for the purpose of colonizing its employes. At the present time most of them live at Philadelphia and are forced to commute daily. Although the company has made no definite statement, it is understood that substantial houses will be erected and that they will be rented at a very low rate.

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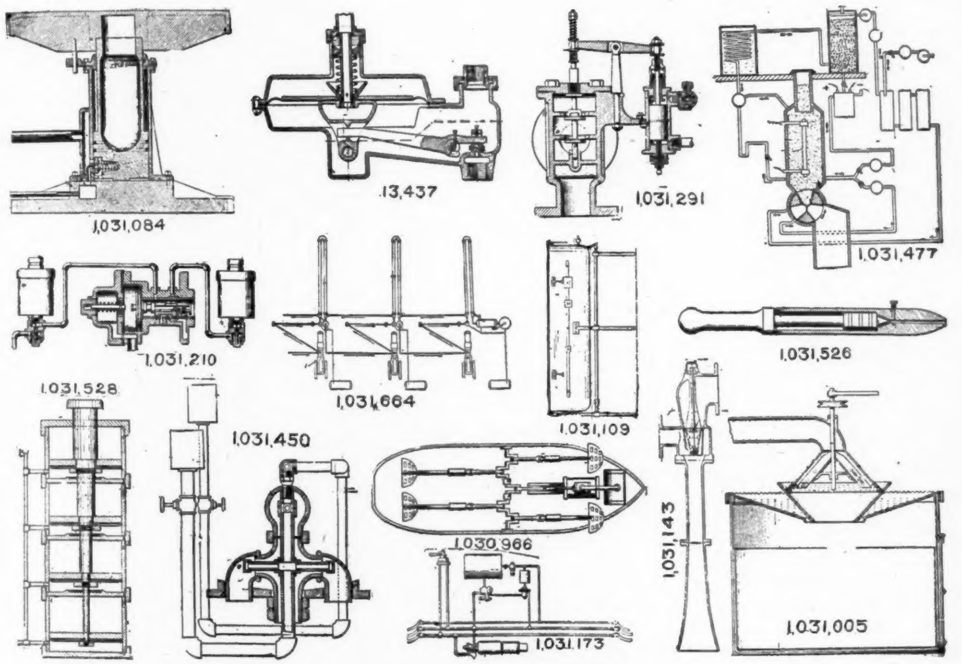
A task of great magnitude is being undertaken by the Japanese Home Department in the dredging of the Straits at Shimonoseki. For this purpose a large number of dredges are required, and there has just been launched at Uraga the dredger *Noda Maru,* which is a powerful vessel capable of dredging at a depth of 40 feet. The work contemplated will take 10 years, and the estimated outlay will be $6,750,000. A channel 17½ miles long and 3,600 feet wide will be deepened to 33 feet. The *Noda Maru* is the latest and biggest vessel to be engaged in this work, the object of which is not only to aid commerce, but to provide an anchorage for dreadnoughts.




Pneumatic Patents, July 2.

## LATEST U. S. PATENTS

*Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.*

JULY 2.

1,030,871. FLUID-ACTUATED TOOL. Charles T. Carnahan, Denver, Colo.
1,030,966. PNEUMATIC PROPELLING MECHANISM. Thomas W. Black, Chicago, Ill.
1,031,005. SUCTION APPARATUS. Louis Isaacs, Louisville, Ky.
1,031,007. SIPHON. Edward M. Johnson, Jersey City, N. J.
1,031,084. SAND-MOLDING MACHINE. William C. Norcross, Terre Haute, Ind.
1,031,109. RESUSCITATING APPARATUS. William G. Euston, St. Louis, Mo.
1,031,141. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Gustave P. S. Miller, Brooklyn, N. Y.; Nellie Anderson administratix of said Miller.
1,031,143. HYDRAULIC AIR COMPRESSOR OR PUMP. Otto H. Mueller, Camberwell, England.
1,031,151. PNEUMATIC PUMPING APPARATUS FOR VACUUM-CLEANERS. John W. Smith, Chicago, Ill.
1,031,168. FLUID-ACTUATED TOOL. Charles T. Carnahan, Denver, Colo.
1,031,173. FLUID-PRESSURE REGULATOR. Clyde C. Farmer, Chicago, Ill.
1,031,176. COMBINED NOZZLE SPRAYER, AND SPRINKLER. Albert D. Gilpin, Lincoln, Neb.
1,031,210. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.
1,031,291. PRESSURE-GOVERNOR. George M. Richards, Erie, Pa.
1,031,450. FUEL-OIL BURNER. Martin L. Kline, Agricola, Kans.
1,031,477. PROCESS OF BINDING AND UTIL-

IZING AIR-NITROGEN. ALF SINDING-LARSEN, Christiania, Norway.

1,031,526. GUN. NEWTON HESTON CLOUD, JR., Wilmington, Del.

1,031,528. SECTIONAL CYLINDER AIR-JACK. CHARLES HENRY COLE, Pueblo, Colo.

1,031,617. AUTOMATIC AIR-BRAKE COUPLING. ELI BIXLER, Berne, Ind.

1,031,664. ART OF THE CONDENSATION OF GASES OR VAPORS INTO THEIR LIQUID FORMS. FRANKLIN P. PETERSON, Grove City, Pa.

1. The art or process of condensing and separating differing compounds in natural gas in which there are different critical pressures and temperatures which consists in compressing and cooling the gas and collecting the liquid condensed and then compressing and cooling the gas residue and collecting the liquid from the residue.

13,437. (Reissue). GAS-REGULATOR. ARTHUR L. PICKERING, Anderson, Ind.

1,031,816. PNEUMATIC - DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,031,834. FLUID-PRESSURE ENGINE. BENJAMIN BRAZELLE, St. Louis, Mo.

1,031,838. BEER-SAVING APPARATUS. JOSEPH CHOQUETTE, St. Hyacinthe, Quebec, Canada.

1,031,875. PNEUMATIC CAR DUMPING AND RIGHTING DEVICE. NICHOLAS SCHAEFERS, Ludlow, Ky.

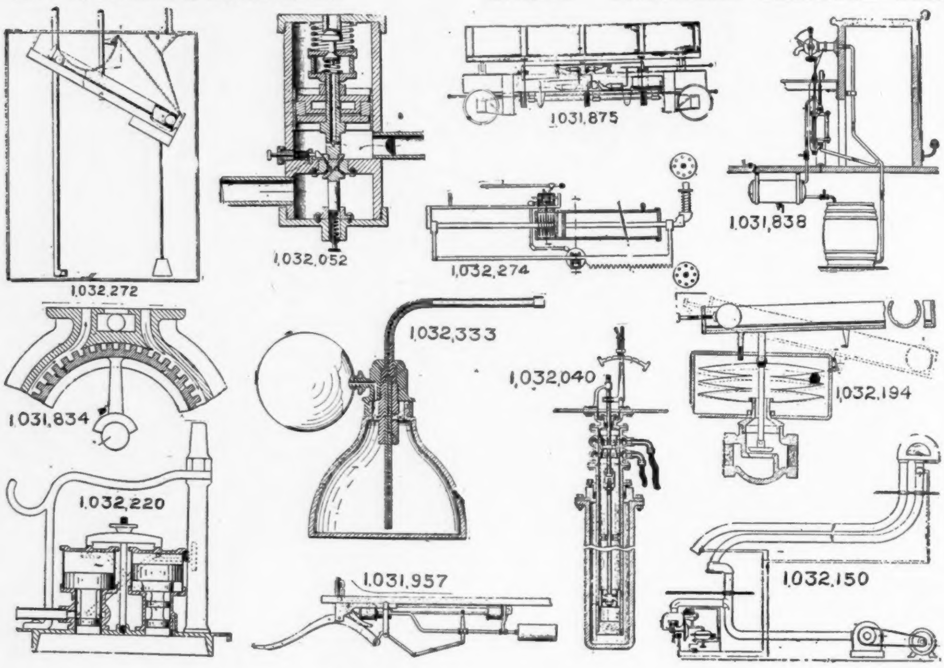
1,031,884. VACUUM-BOTTLE. LOUIS J. STILLING, Newark, N. J.

1,031,957. FENDER. WILLIAM FRANCIS O'ROURKE, Philadelphia, Pa.

1,032,040. HYDROPNEUMATIC PLUNGER-ELEVATOR. LEONARD ATWOOD, Farmington Falls, Me.

1,032,052. PRESSURE-REGULATOR. ERNEST W. EVANS, Robinson, Ill.

1,032,141. PNEUMATIC - DESPATCH - TUBE




PNEUMATIC PATENTS, JULY 9.

APPARATUS. CHESTER S. JENNINGS, Boston, Mass.

1,032,147. TURBO-COMPRESSOR. ERNST WILHELM KOSTER, Frankfort-on-the-Main, Germany.

1,032,150. PNEUMATIC - DESPATCH - TUBE APPARATUS. JAMES G. MACLAREN, Weehawken, N. J.

1,032,155. PNEUMATIC - DESPATCH - TUBE APPARTUS. ALBERT W. PEARSALL, Lowell, Mass.

1,032,194. AUTOMATIC GAS-VALVE. ROBERT T. EVANS, and WALTER G. NORD, Youngstown, Ohio.

4. In a device of the character described, the combination with fluid-pressure operated mechanism; of means, including a cylindrical runway oscillatorily mounted upon a horizontal axis, and a weighted ball adapted to move in said runway upon oscillation thereof, said means being operated by said mechanism upon a change in such fluid-pressure and being adapted thereupon to retain said mechanism in a fixed position

## JULY 9.

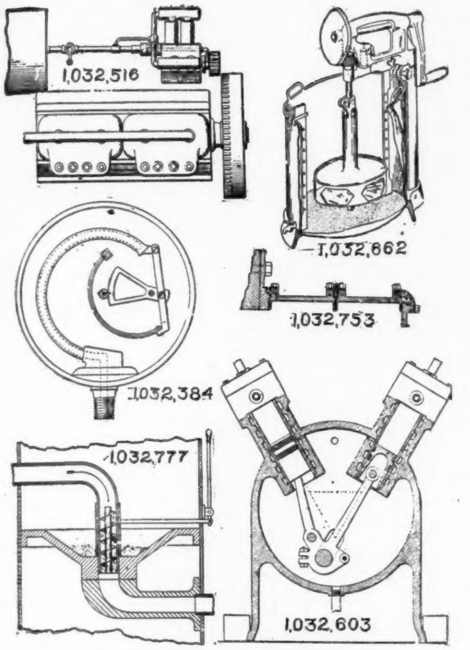
1,031,742. PNEUMATIC - DESPATCH - TUBE APPARATUS. CHARLES F. STODDARD, Boston, Mass.

1,031,774. TERMINAL FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. JAMES T. COWLEY, Boston, Mass.

1,031,801. VACUUM-PUMP. HARRY D. MADDEN, Bloomfield, N. J.

1,031,814. PROCESS OF PRODUCING PLASTIC SUBSTANCES FROM MILK. OTTOKAR HENRY NOWAK, Chicago, Ill.

4. The process herein described for the manufacture of milk products consisting in eliminating soluble matters from the curd of milk, dissolving the coagulum under agitation, re-coagulating the solution under agitation by an acid or acid salt, adding a ketone to the coagulum, comminuting the coagulum in water, expressing the water from the mass, forming the mass into layers, and drying the layers under pressure in a vacuum.




PNEUMATIC PATENTS, JULY 16.

against succeeding changes in pressure; and a screw-bolt mounted at the normally lower end of said runway and adapted to position said ball therein, thereby permitting operation of said first-named means only upon a predetermined change in such fluid-pressure.

1,032,220. ELASTIC-FLUID MOTOR FOR MILKING APPARATUS. ALBERT KILBORN, Middle Brighton, Victoria, Australia.

1,032,272. COMPRESSED-AIR WATER-ELEVATOR. ARTHUR O. BROWN, Chicago, Ill.

1,032,274. DEVICE FOR STARTING INTERNAL-COMBUSTION ENGINES. DAVID ELDRIDGE CROUSE, Annapolis, Md.

3. In a device for starting internal combustion engines, a pinion on the engine shaft, a pivoted rack arranged to engage said pinion, a spring for moving said rack into engagement with said pinion, pneumatic means for swinging the rack out of alinement with said pinion, pneumatic means for retracting the rack when out of alinement with the pinion, and for compressing said spring, and a second spring for swinging the rack into its original position.

1,032,333. ATOMIZER. WILLIAM S. HAY, Providence, R. I.

JULY 16.

1,032,384. PRESSURE-GAGE. ROBERT M. DIXON, East Orange, N. J.

1,032,516. ENGINE-STARTER. WILLIAM L. STULLER, Detroit, Mich.

1,032,603. AMMONIA-COMPRESSOR. WILLIAM H. HAYNER, Fort Wayne, Ind.

1,032,663. AERATING BUTTER-SEPARATOR. ALPHEUS FAY, Louisville, Ky.

1,032,753. GAS AND AIR TIGHT JOINT. BURT S. HARRISON, New York, N. Y.

1,032,777. SAND-BLAST APPARATUS. LUDWIG SAUER, Kitzingen, Germany.

1,033,000. PNEUMATIC PIANO-PLAYER. JOSEPH LESLIE FORSTER, Vancouver, British Columbia, Canada.

1,033,010. MANUFACTURE OF PNEUMATIC CUSHIONING DEVICES FOR THE ELASTIC SUSPENSION OF ROAD-VEHICLES. LEONARD HARRIS, London, England.

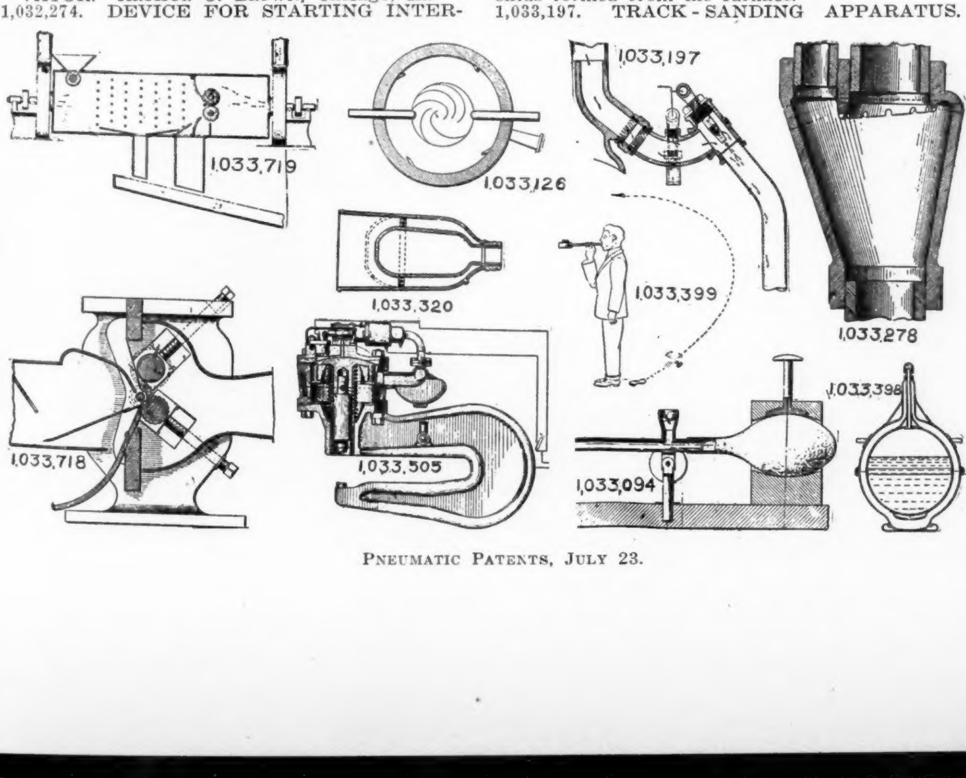
JULY 23.

1,033,094. TARGET AIR-GUN. RALPH FUDA, Norfolk, Va.

1,033,126. METHOD OF PRODUCING ENDOTHERMIC COMPOUNDS FROM THEIR COMPONENTS. WERNER SIEBERT, Rheinfelden, Baden, Germany.

2. The method of producing nitric oxids from the air, consisting in forming an arc in the center of a cylindrical electric furnace between electrodes, the points of which are in a horizontal plane, forcing the air through nozzles distributed along the inner periphery of the furnace at so great a speed as to produce within the furnace a violent whirl of air capable of horizontally spreading the air, whereby a disk-shaped flame is formed, the heat of which can combine the essential components of the air to form nitric oxids, and in discharging the nitric oxids formed from the furnace.

1,033,197. TRACK-SANDING APPARATUS.




PNEUMATIC PATENTS, JULY 23.

FREDERICK ROTHWELL, Montreal, Quebec, Canada.

1,033,216-7. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. EUGENE T. TURNEY, Rock Island, Ill.

1,033,278. AIR-LIFT. JOHN P. SIMMONS, San Francisco, Cal.

1,033,320. VACUUM WALL-RECEPTACLE. ORLANDO J. W. HIGBEE, Pittsburgh, Pa.

1,033,398. METALLIC VESSEL FOR LIQUEFIED GASES. CHRISTIAN WILHELM PAULUS HEYLANDT, Schulau, Germany.

1,033,399. AERIAL TOY. GEORGE HEYLMAN, North San Diego, Cal.

1,033,438. PNEUMATIC PLAYER FOR MUSICAL INSTRUMENTS. WILLIAM T. MILLER, Boston, Mass.

1,033,505. POWER DEVICE. MORRIS C. WHITE and OTHO C. DURYEA, Chicago, Ill.

1,033,718. PNEUMATIC COTTON-GIN. JOHN J. MCNALLY, Norfolk, Va.

1,033,719. SEED-COTTON SEPARATOR. JOHN J. MCNALLY, Norfolk, Va.

1. A seed cotton separator comprising an air blast chamber, and separator rolls in the path of the blast moving in contact with one another, one of said rolls being fluted longitudinally and the other being channeled circumferentially.

1,033,923. WAVE-MOTOR. JACOB NYSWANDER, Puente, Cal.

1,033,993. LAUNCHING TORPEDOES. GREGORY C. DAVIDSON, Quincy, Mass.

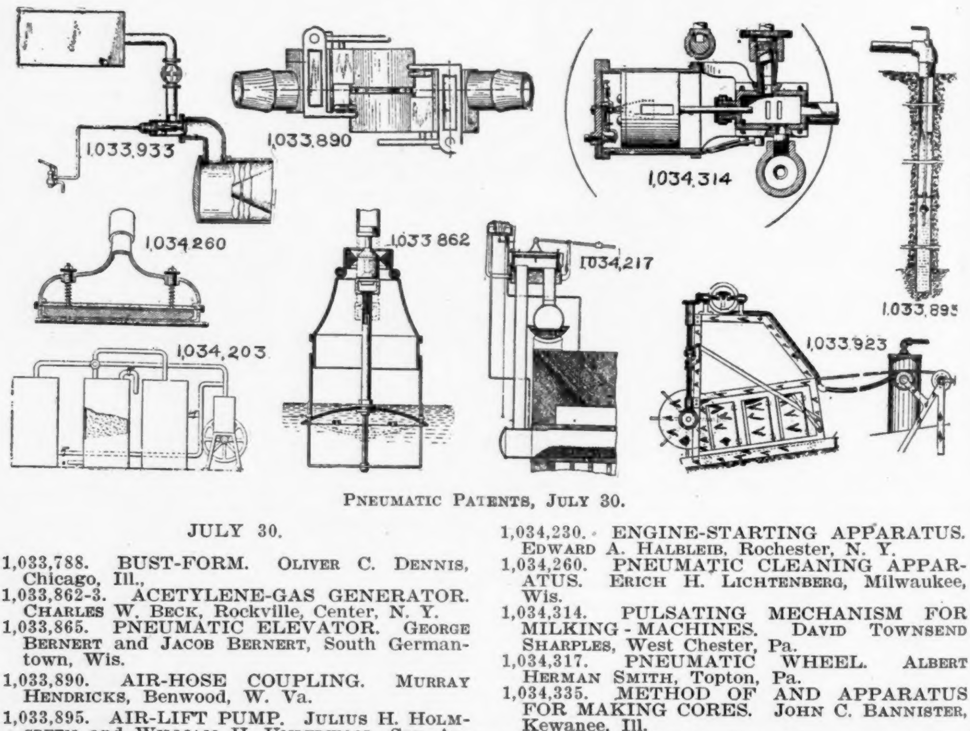
1. In torpedo launching apparatus, a launching tube, a reservoir for motive fluid under pressure, and a conduit for the motive fluid from the reservoir to the space within the launching tube about the torpedo, in combination with pressure controlling apparatus in said conduit for limiting the pressure on the torpedo and maintaining it substantially uniform as the torpedo moves forward in the launching tube.

1,034,052. DRILL FOR ROCK, COAL, AND OTHER MATERIAL. SAMUEL S. WYER, Columbus, Ohio.

1,034,203. PROCESS OF AGGLOMERATING MATERIALS. PAUL CLAES, Brussells, Belgium.

1,034,215-6. APPARATUS FOR REMOVING SUSPENDED MATTER FROM GASES AND VAPORS. HENRY L. DOHERTY, New York, N. Y.

1,034,217. METHOD OF EQUALIZING PRESSURES. HENRY L. DOHERTY, New York, N. Y.




PNEUMATIC PATENTS, JULY 30.

JULY 30.

1,033,788. BUST-FORM. OLIVER C. DENNIS, Chicago, Ill.,

1,033,862-3. ACETYLENE-GAS GENERATOR. CHARLES W. BECK, Rockville, Center, N. Y.

1,033,865. PNEUMATIC ELEVATOR. GEORGE BERNERT and JACOB BERNERT, South Germantown, Wis.

1,033,890. AIR-HOSE COUPLING. MURRAY HENDRICKS, Benwood, W. Va.

1,033,895. AIR-LIFT PUMP. JULIUS H. HOLMGREEN and WILLIAM H. UNDERWOOD, San Antonio, Tex.

1. In an air-lift pump, a water-discharge pipe open at its lower end, an air-supply pipe leading into the lower part of the water-discharge pipe, and an atomizer in the lower part of the water-discharge pipe communicating with the air-supply pipe, said atomizer comprising a shell with numerous small air-passages leading through its wall in upward and outward directions and said shell having a sediment-eduction opening in its bottom.

1,033,918. CAR-VENTILATOR. JOSEPH T. MERCIER, Chicago, Ill.

1,034,230. ENGINE-STARTING APPARATUS. EDWARD A. HALBLEIB, Rochester, N. Y.

1,034,260. PNEUMATIC CLEANING APPARATUS. ERICH H. LICHTENBERG, Milwaukee, Wis.

1,034,314. PULSATING MECHANISM FOR MILKING-MACHINES. DAVID TOWNSEND SHARPLES, West Chester, Pa.

1,034,317. PNEUMATIC WHEEL. ALBERT HERMAN SMITH, Topton, Pa.

1,034,335. METHOD OF AND APPARATUS FOR MAKING CORES. JOHN C. BANNISTER, Kewanee, Ill.

1,034,336. METHOD OF AND APPARATUS FOR MAKING MOLDS AND CORES. JOHN C. BANNISTER, Kewanee, Ill.

13,450. (Reissue). STARTER FOR INTERNAL-COMBUSTION ENGINES. LUTHER V. MOULTON and PALMER A. JONES, Grand Rapids, Mich.

1. An engine starter, comprising mechanism for distributing fluid under pressure to the respective engine cylinders in succession, a throttle valve adapted to control the flow of said fluid and manually operated means for simultaneously operating said mechanism and throttle valve.